The Library of Congress'

EARLY STATE RECORDS PROJECT

converted from the original microfilm held by the
Vincent C. Immel Law Library, Saint Louis University

through the generous support of a grant from the

Council on Library and Information Resources

Wisconsin Geological Survey reports

reformatted from the original and including:

Geological report, 1854, <1860>

Annual report on the Geological Survey of the State of Wisconsin, 1855-1856

Report, 1857

Report of the Commissioners of the Geological Survey, <1858>

LLMC 01-229t

GEOLOGICAL REPORT.

To his Excellency, LEONARD J. FARWELL,
Governor of Wisconsin:

I herewith transmit to you the first annual Report upon the Geology of Wisconsin, made in accordance with an act of the Legislature, authorizing a geological survey of this State, and with the execution of which, I have been entrusted by your Excellency.

The provisions of the bill, under which I act, require that the district known as the "Lead Mines" should be surveyed before commencing any other portion of the State. I have therefore confined myself to this district in conducting the survey, and shall continue to do so until I have completed its exploration. The great intrinsic importance of the lead mines, and the general misapprehension which exists in regard to them, both at home and abroad, demand that some authentic and reliable information of their character and resources should be laid before the public. In this report are embodied such facts and conclusions, bearing upon this point, as the brief researches of the past season have enabled me to furnish. They are entirely practical in their character, and confined mainly to the economical geology of the district. In all the investigations made, my inquiries have been directed to one object, viz: To ascertain what useful mineral substances existed in the district; their mode of occurrence; and the best method of rendering them available in the practical uses of life. Inciden-

tally, however, many facts of great scientific interest have been collected, which will be presented in my final report. A large collection of specimens, very fully illustrating the rocks, have been collected for the cabinet of the State University. These will be increased by constant additions during subsequent seasons, furnishing materials for a State collection which, when properly arranged, will be second in beauty and interest to none in the country. When it is remembered that only about eight months intervened between the date of my commission and that of my report, and, that in this brief period, I have spent six months in the field, it will not be surprising if some mistakes occur. I have spared no pains to render them as few as possible, and feel confident that the leading conclusions of this report will be found correct. Upon many points I have refrained from expressing an opinion, until more light is thrown upon them by future investigation. Hasty reports have justly fallen under the condemnation of practical geologists. To those familiar with the great variety of researches required for a geological survey, the utter impracticability of hastening the process without lessening the value of the results, will be evident. The mind cannot furnish safe and matured conclusions unless it is given time to elaborate them by patient investigation. The labors of the study are therefore quite as necessary to the geologist, as those of the field. With the brief time and limited means at my disposal, it is obvious that the survey of a district so large, and containing so many points of interest, must be yet incomplete. I have here presented such matter as seemed necessary to be made public, to redeem the lead region from the disrepute into which it has fallen, and hasten the development of its resources. By the labors of the past season, observation has been stimulated among those operating in the mines, and processes have been commenced by which numerous facts will be gathered, relating to many obscure and difficult problems. Thus, many points, now doubtful, will be settled, and errors arising from hasty deductions will be corrected. As early as possible in the ensuing spring, I shall resume the survey of the lead mines, and

after completing it, proceed as soon as possible to other portions of the State.

In writing this report, technical terms have generally been avoided, but as they are sometimes unavoidable, a glossary of those used has been appended.

An appendix upon the Iron mines of Wisconsin will be found at the close of the report. The explorations upon which it is based were made before receiving my appointment, at my own expense. The great importance of calling early attention to this interest has induced me to submit a brief statement of its value.

The paper upon the scenery of the lead region, by H. A. TENNEY, Esq., contains an excellent general description of the country. Mr. TENNEY accompanied me during a portion of the season, and rendered valuable assistance.

I. A. LAPHAM, Esq., of Milwaukee, well known for his valuable contributions to several departments of science, has kindly volunteered to act as Palæontologist to the survey. His report on the fossils of the State, will be furnished when the collection shall be sufficiently full to furnish data for preparing it.

Dr. HAYES of Boston, Assayer to the State of Massachusetts and one of the most distinguished chemists in America, has been employed to make the chemical analysis for the survey. His report upon the Zinc ores of our State, herewith transmitted, contains matter of great importance. The analysis of other minerals is in progress, and will be published as soon as completed.

My acknowledgments are due to J. B. TURNER, Esq., President of the Galena and Mississippi R. R., and JOHN CATLIN, Esq., President of the Milwaukee and Mississippi R. R., for free passage over their respective roads in the discharge of my official duties; also, to HUGH LEE and CHARLES PURPLE, Esqs., and Messrs. GERMAIN and VLIET, Civil Engineers, for information and assistance. So numerous are my obligations to the inhabitants of the lead region, that I cannot, without an invidious selection or tedious enumeration, express them personally. My efforts have been almost universally seconded by the people, and I shall always re-

member, with sincere gratitude, the many kind personal attentions received at their hands.

In concluding this introductory note, let me tender my thanks to your Excellency for the interest which you have taken in the survey, and express my hearty appreciation of your kindness in furnishing every facility in your power for its successful prosecution.

Sincerely hoping that this report may be useful in aiding the development of our mineral resources, and advancing the prosperity of our State,

I have the honor to subscribe myself

Your Obedient Serv't,

EDWARD DANIELS,

STATE GEOLOGIST.

REPORT.

CHAPTER I.

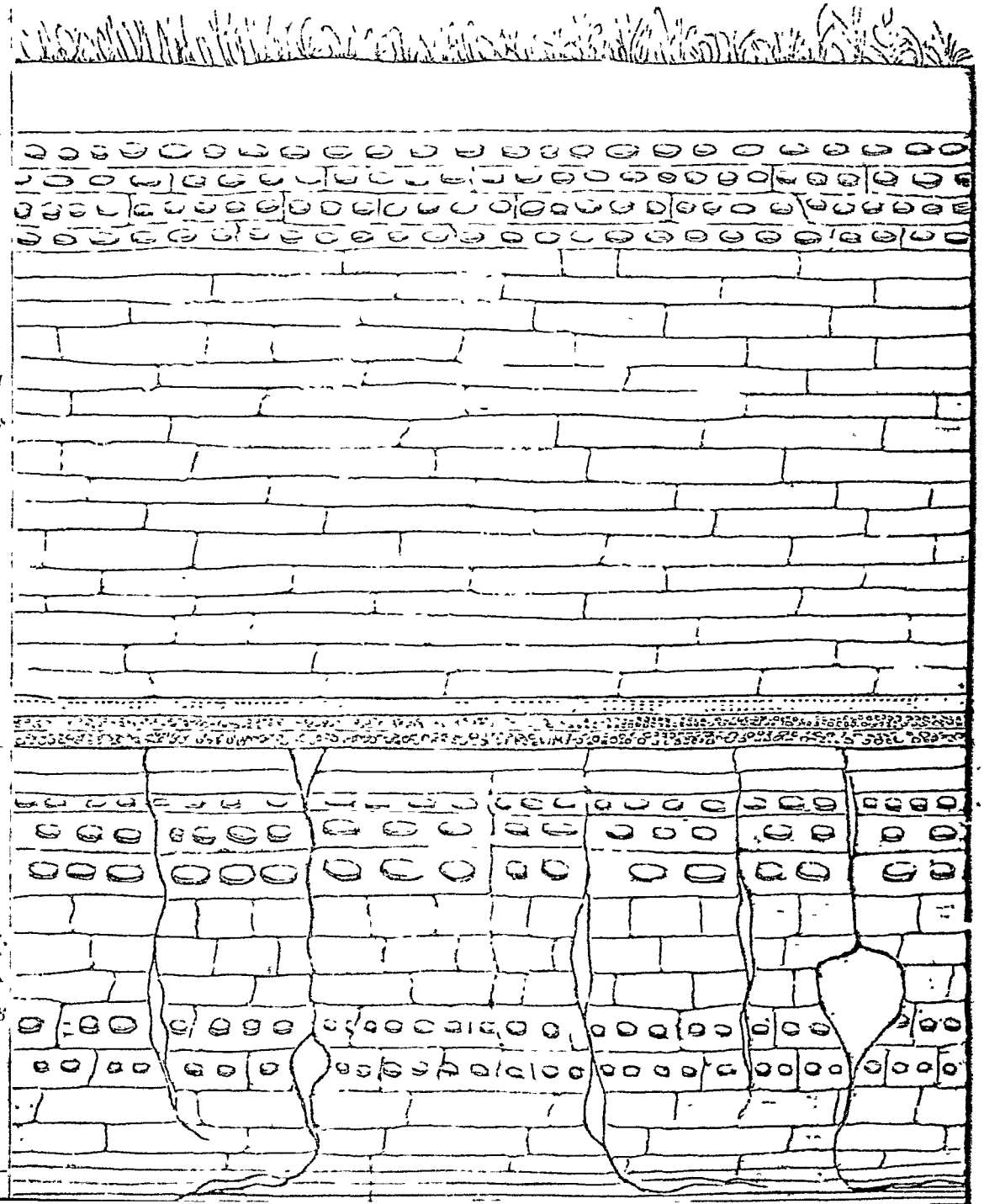
The lead region of Wisconsin includes an area of about 3500 square miles, occupying the south-west corner of the State, and including the counties of Grant, Lafayette, Iowa, Green, and the western portion of Dane. Its approximate boundaries are: the Wisconsin river on the north; Sugar river on the east; the State line on the south; and the Mississippi on the west. Its extent, from east to west, is about seventy miles; and its average width, from north to south, fifty miles. The surface is generally undulating, but rarely broken except near the large streams. The general altitude is about 600 feet above Lake Michigan. A few isolated points rise above the general level, which have received the appellation of mounds. The highest of these is the Blue Mound, situated in the north-east portion of the district, and rising nearly 1200 feet above the Mississippi. It is the culminating peak of the great dividing ridge between the waters flowing north into the Wisconsin, and south into Rock river and the Mississippi. The drainage of the district is very rapid and perfect. It is entirely destitute of lakes and swamps. Its surplus waters are carried away by numerous streams, remarkable for their rapid flow and the purity of their waters. About one-third of the surface is prairie, dotted and belted with beautiful groves and oak-openings. The scenery combines every element of beauty and grandeur—giving us the sunlit prairie, with its soft swell, waving grass and thousand flowers;

the sombre depths of primeval forests; and castellated cliffs, rising hundreds of feet, with beetling crags which a Titan might have piled for his fortress. Such are the location and prominent physical characteristics of the country occupied by the lead mines of Wisconsin.

SECTION No. 1.

Vertical Section showing the succession and relative thickness of the rocks which underlie the "Lead Region" of Wisconsin.

Feet.		
20	No. 1. *Surface Clay and Soil.*	
300	No. 2. *Corraline Beds, of* Dr. Owen. *The bed of compact whitish limestone, capping the mounds and table lands.*	
15	No. 3. *Nucula Shale.*	
250	No. 4. *Gray Limestone. The ordinary surface rock of the mines, containing veins of lead, and in its lower beds zinc and copper.*	

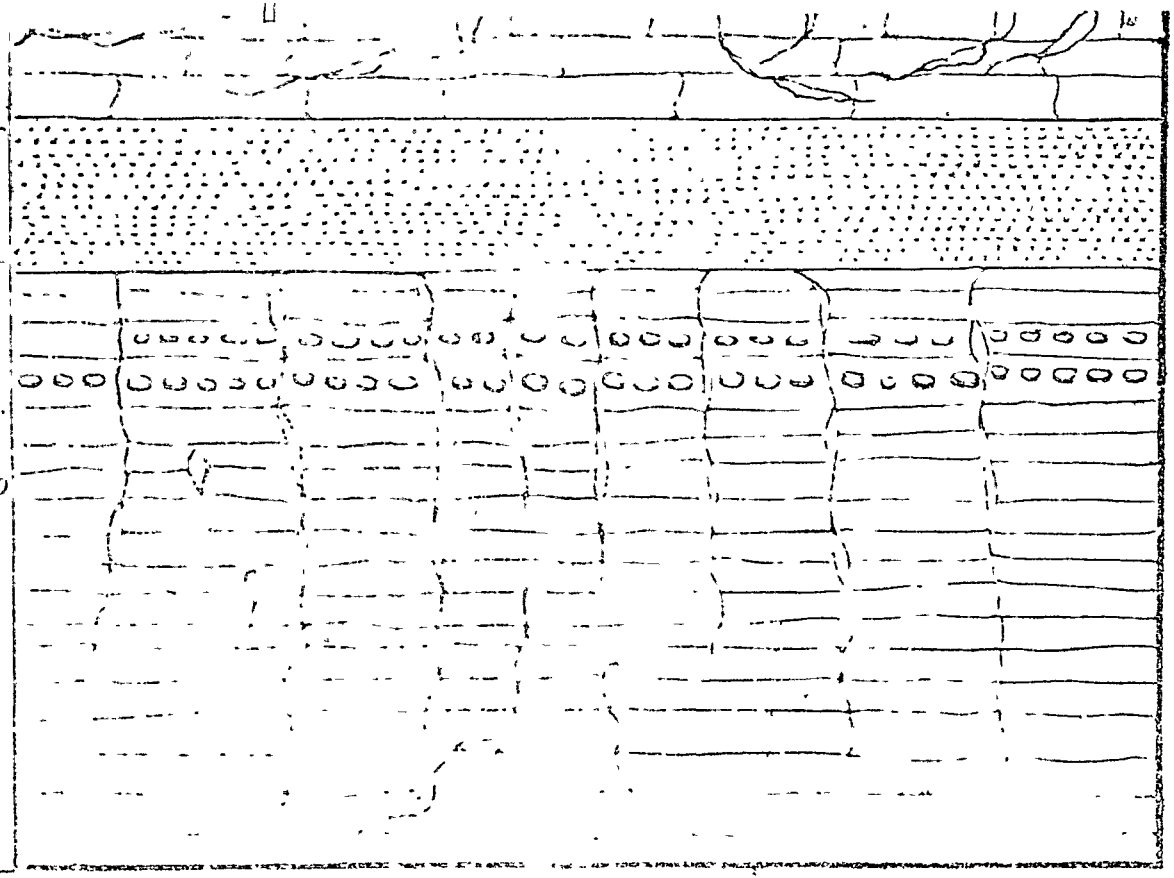


stone.
Vitis cestuine here.

60 No. 7. *Sandstone.*
No fossils in this rock.

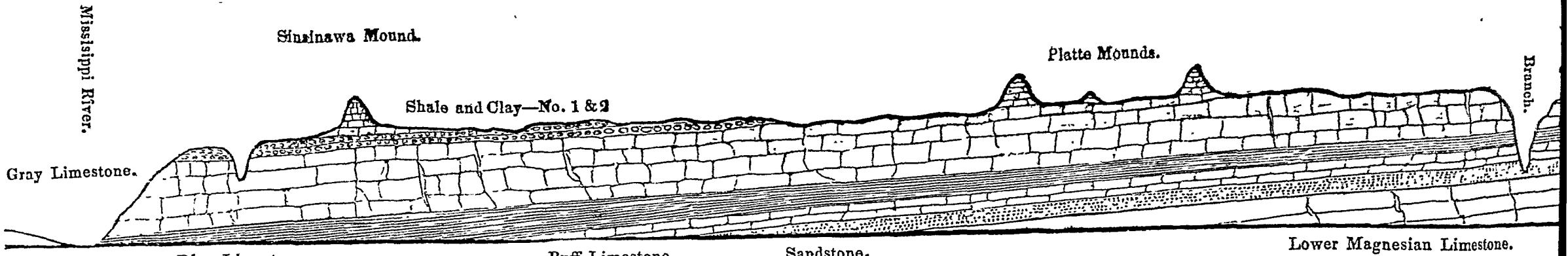
200 No. 8. *Lower Magnesian Limestone of* OWEN.

Proved by recent discoveries to be a lead-bearing rock.



Section No

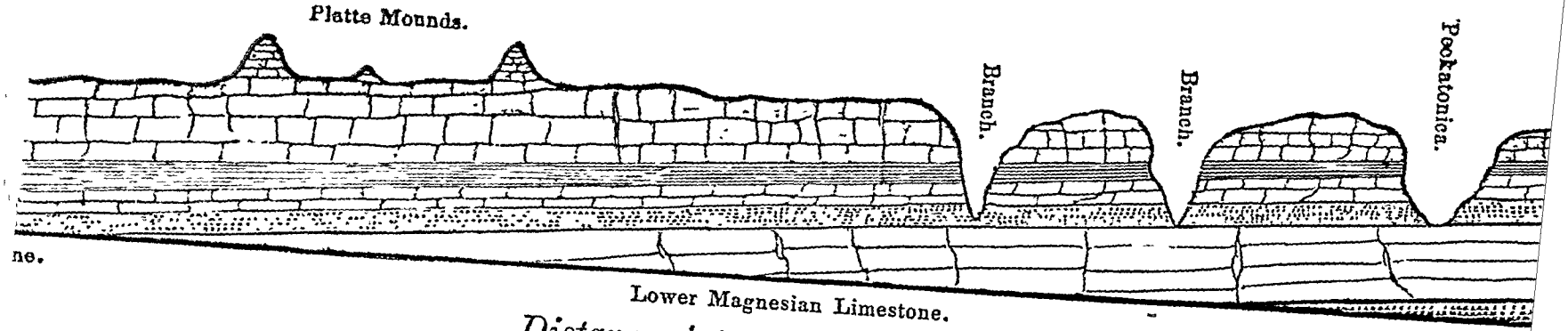
Horizontal Section across the Lead Mines from the Mississippi River opposite Dubuque, to the Blue Mounds, p



Distance sixty miles.—Dip 10

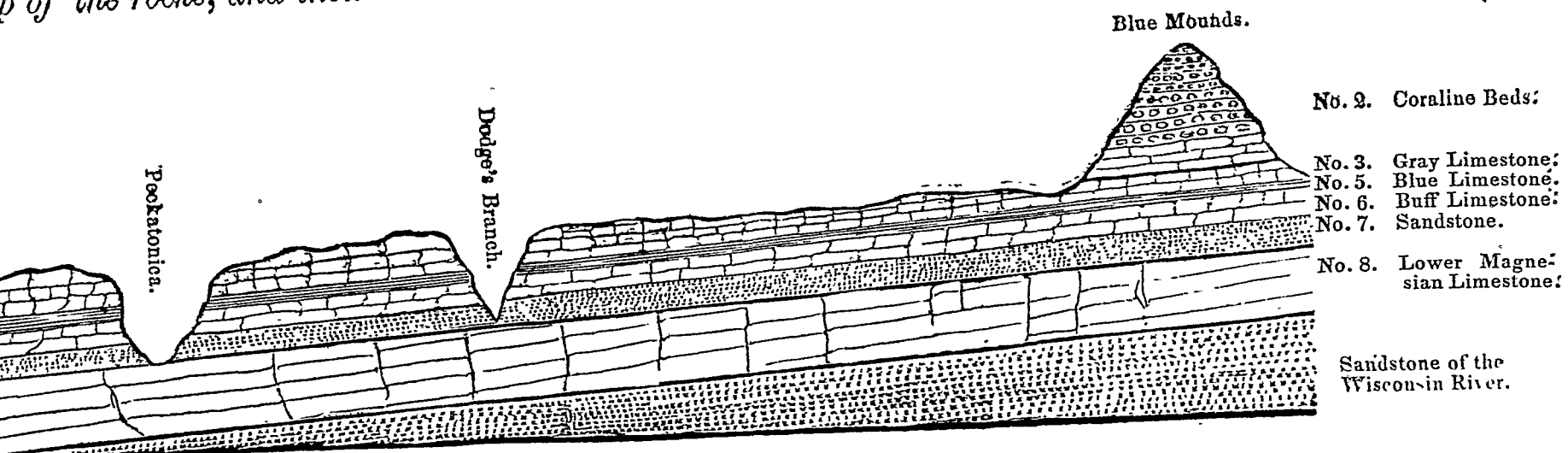
Section No. 2.

he Mississippi River opposite Dubuque, to the Blue Mounds, presenting the dip of the rocks, an



Distance sixty miles.—Dip 10 *feet per mile.*

p of the rocks, and their relation to the surface. Direction from S. W. to N. E.



CHAPTER II.

GEOLOGY OF THE LEAD MINES.

Under this head I propose briefly to describe the prevailing rocks, which underlie the mining district, so far as we have been able to ascertain them. The rocks of the globe are divided by geologists into two great classes, the stratified and unstratified. Those which are found to have a regular arrangement in parallel layers are called stratified, while those which have no such structure, but are irregular and massive in form are called unstratified. The rocks of this district all belong to the former class. They are arranged in regular parallel layers of varying thickness, having generally a position slightly inclined or horizontal. They consist chiefly of limestone and sandstone, with occasional beds of shale and clay. They are arranged one above another in an invariable order, so that they always occupy the same relative position in a vertical scale. The accompanying sections exhibit the order of succession, position, and relative thickness of these rocks, more clearly than any verbal description.

Section No. 1, exhibits the succession of rocks which would be encountered in sinking a shaft from the highest points of the surface to the lowest rocks, which have yet been brought within the reach of our observation. In descending from the surface we shall encounter the following beds in the order here named, as shown in the section.

1st. Clay, from ten, to sixty feet thick.

2d Thin bedded hard white limestone, three hundred feet.

3d. Shale, of blue or brown color.

4th. Thick bedded gray limestone, two hundred feet.

5th. Thin bedded blue or brown limestone, with layers of shale, fifty feet.

6th. Yellowish thick bedded limestone twenty five feet.

7th. Sandstone of various colors, generally light gray or red, forty feet.

8th. Limestone with intercalations of sandstone.

The stratification of these beds is conformable, or very nearly so. The whole series have a south-easterly dip, at the rate of about ten feet to the mile, as seen in section No. 2. These beds I shall now notice more particularly in a descending order, beginning with

No. 1.—Surface Clay.

The thickness of the superficial clay is exceedingly variable, but outside of the vallies it is rarely less than 8 feet. It attains its maximum thickness in the southwestern portion of the district. Near the Sinsinawa Mound, in Jamestown, it assumes the form of pipe clay, and presents several distinct beds, with an aggregate thickness of 60 feet. From this point heavy beds stretch northward for nearly forty miles, differing however from that in Jamestown. At the latter place, and also at Potosi, I found a small fresh water shell, (*Limnea galbana*, of Say,) in great abundance about twenty feet below the surface. So numerous were they, that hundreds were contained in every shovel full of the clay, and so tender that they rapidly decomposed when exposed at the surface. Another class of fossils of great interest are peculiar to these clay beds. I allude to the gigantic bones which have been discovered at Fairplay and Potosi. Those found at Fairplay are now in the possession of J. Potts, Esq., of Galena. They belong to an elephant and mastodon. They are in a very fair state of preservation, and will be more fully described hereafter. Two discoveries of this character have been made at Potosi. Of one I could obtain only a verbal account, as the specimens had all been destroyed or carried away. In the other case I succeeded, through the kindness of Mr. Hull, upon whose ground the bones were discovered, in obtaining a few small pieces. Among these was a fragment of a tooth, which proved the owner of the huge bones to have been an elephant. The bones were so far decayed that

they crumbled to dust as soon as the dirt was removed from them; otherwise the entire skeleton of the elephant might have been secured. I may remark in this connection, that I have received from LUTHER IRISH, Esq., of Sextonville, Richland county, a very fine elephant's tooth found at that place under similar circumstances. These discoveries are replete with interest, as furnishing data from which the past history of our State, at periods immensely remote, may be constructed. They prove beyond question, that the elephant and mastodon once roamed over its hills and vallies; and that these gigantic quadrupeds found favorite places of resort upon the very sites of our now populous towns. It was long, long ago; for the lakes and rivers from which they drank are now dry; and the forests amid which they wandered, and upon whose luxurious vegetation their colossal forms were fed, have disappeared forever.

The origin of this surface clay seems to have been in great measure owing to the decomposition of the rocks, which once occupied its place. This is proved from the frequent occurrence in it of flints and lead ore, which have survived the waste of the rocks in which they were once imbedded. The peculiar character of the clays in the western part of the district, however, together with the fossils which they contain, indicate that a large fresh water lake must have once existed there. A remarkable fact in the superficial deposits of this region is the entire absence of the drift so abundantly represented over the north-west generally, by boulders, gravel, sands, and clay. So far as my observation extends, not a single boulder or gravel stone can be found over the whole district. The surface material bears no evidence of distant origin, and unless some of the clays shall be proven diluvial we have here no traces of transported drift. Whatever then may have been the agency which dispersed the huge masses of rock, fragments of native copper, beds of sand and gravel, so lavishly over the surrounding country, we know, that by some peculiarity of position the lead region was above its reach. Widely removed as this circumstance may seem from practical matters, it has nev-

ertheless a most important bearing upon the economical value of the district to which it relates. For had it been otherwise the whole surface would have been covered with loose deposits, often of great thickness, burying all indications of the presence of lead veins, rendering discovery exceedingly doubtful, and profitable mining a practical impossibility. The precise boundary of the district thus destitute of drift, is not yet ascertained.

Number 2.

Next in the order of geological position are the beds of limestone forming the highest points of the surface, capping the mounds and table-lands. These have been called the "coraline beds of the cliff limestone," by Mr. Owen, on account of the great abundance of fossil corals which they contain. The greatest thickness of this rock is about 400 feet. Its strata vary much in thickness, but are usually thin. Its color is light gray, texture crystaline, and occasional layers of flint are disseminated through it, aggregated into nodules. It has been quarried at Sinsinewa and Platte Mounds, and furnishes an excellent building material. The fossils are very abundant and well preserved, and usually silicious. The most common forms are the beautiful chain coral, (*catenipora*,) the *pentamerus oblongus*, popularly known as a "petrified nut;" and the fossil coral, known as "petrified honey comb." This formation is now represented here by a few outlayers, capping the mounds, and extending a thin skirt over the surrounding table lands.

This slight horizontal development, as compared with its great thickness, has undoubtedly been caused by the wearing away of these beds from a large portion of the surface which they once occupied.

The amount of erosion that the surface of the district has suffered, is immense, and may be seen by reference to section No. 2. Here the dotted lines, extending from the top of the Blue Mound to Sinsinewa, indicate the extent of this formation before it had been acted upon by the agencies of waste. The whole space be-

tween these mounds, and below this line, has been worn away by the action of atmospheric agents and running water. The mounds are merely remnants or outlayers. Their existence may be assigned to two causes. First, greater hardness of texture than the surrounding rocks, enabling them longer to resist the destructive action of the elements; Second, an original elevation above the general level, making them the centers of drainage from which all the streams radiate. This would relieve them, in some measure, from the erosion of running water, by which the adjacent levels, less favorably located in this particular, would be worn away around them. The Blue Mounds are capped by a mass of stratified hornstone or flint, nearly 300 feet thick. It contains fossils resembling those of the coraline beds. The occurrence of such a mass of silicious matter in this form, is a very striking phenomenon. That it must have originated under similar circumstances to the limestones with which it is associated, is proved by the fact that it contains the same fossils, but it is evident that some local agency must have been active in forming a deposit so extensive and anomalous at this point, while it occurs only in small quantities elsewhere. The abundance of fossil corals found upon these mounds remind us of the scattered fragments about a modern coral reef. They prove that these mounds were once the sites of similar operations, where the little coral animals reared their stony architecture beneath an ocean whose waters covered the whole land. Under this ocean the beds of limestone which I am describing, were slowly formed, partly by the deposition of lime, held in solution, and partly by the slow growth of corals and shells, whose curious and beautiful forms they contain in such abundance.

Number 3.

Underneath the coraline beds, we find a shale bed. It is most largely developed in the southwest portion of the district, and gradually thins out towards the north and east. At Fairplay it attains a thickness of about 12 feet. Its general texture is soft

and crumbling. Its color is blue, green, and sometimes brown or yellow. The upper portion of the bed contains circular nodules resembling clay stones, and consisting mainly of iron oxide. Calcareous nodules of a lenticular form are also found cemented together in such quantity as to form nearly the whole bulk of some strata. This part of the formation is generally destitute of fossils. The lower portions, however, are wonderfully rich in petrifactions, preserved in the highest perfection. The entire rock is often a mass of fossils, with barely enough of some cement to hold them together. These fossils are mainly shells. Among them we find abundantly, *pleurotomaria*, *endoceras*, *modilopsis*, *nuculaformis*, *clidopherous-planulatus*, *nucula-poststriata*, *lingula*, with a few *trilobites* and other fossils unknown.

It is a singular fact, that all these fossils are exceedingly minute as compared with those of similar types, found in the rocks below. The huge chambered shells of the lower limestones, measuring often six feet in length and two feet in diameter, are here represented by forms, rarely exceeding four inches in length, and one inch in diameter. The *nucula* of the gray limestone is often two inches in length, while that of the shale is only one-third of an inch long. A similar diminution seems to have affected every form of life; constituting as it were, a fossil Lilliput, analagous to what Hugh Miller has described as the "age of dwarfs," among the fishes of the old red sandstone.

This deposit extends across the Mississippi into Iowa, and south into Illinois. It offers to the naturalist a new field of investigation, replete with interest and instruction. In this brief notice I can barely call attention to the fact of its existence, but hope at some future time to present a fuller account of it and its wonderful fossils. I have called it for the present the "nucula shale," from the great numbers of this fossil which it contains.

Number 4.

Next, succeeds the gray limestone. This is the prevailing surface rock of the mines. Its upper beds consist of a very hard

whitish limestone, with few fossils, the most common of which is the *lingula Iowensis* of Mr. Owen. The black oxide of manganese often covers the surface of the layers with beautiful markings, resembling the delicate branchings of the mosses. These layers form what is called the cap rock to the perpendicular veins of the western portion of the mines. The succeeding layers are of a bluish gray color, of a more open texture, and when examined closely are found to consist of minute crystals of carbonate of lime. This rock often contains sulphuret of iron, by the decomposition of which it assumes a yellowish cast in weathering, and yields as it crumbles, those loose beds resembling sand, and so often mistaken for that substance in the mines. A glass of moderate power detects the mistake, and shows the grains of which it consists to be angular crystals of lime.

The fissures which in the upper layers are represented by mere seams, here expand in width often several hundreds of feet, forming the great caves, for which the region bordering the Mississippi is especially noted. These fissures are the great repositories of lead ore. They are usually filled with clay and loose materials, which have washed in from the surface. The layers of this rock are from one to four feet thick. Nodules of flint arranged in parallel layers, are of frequent occurrence.

The lowest beds of the gray limestone are disposed in thin layers of a chocolate or reddish-brown color, known among miners as the "brown rock." This rock contains great quantities of calc. spar or "tiff." The entire rock in some cases seems to have been metamorphosed, being converted into "tiff," with a residuum of earthy matter. This metamorphic action seems to have occurred only in the vicinity of fissures.

The characteristic fossil is a circular coral, (*coscinopora sulcata*,) popularly called the sun-flower coral, and sometimes taken to be a petrified wasp's nest.

Number 5.

The blue limestone lies immediately below that last described.

It consists of soft shales interstratified with very compact limestone. It is generally thin bedded, of a blue or brown color when recently fractured, and intersected with numerous joints. It is remarkable for the frequent alternation of its strata; the vertical thickness of a few feet often presenting layers widely differing from each other in texture.

The fossils of the blue limestone are very abundant and well preserved. They are mainly shells, corals and crustacea, with frequent impressions of fucoids, or sea-weeds, ramifying over the surface of its layers.

The lower layers are thicker and less fossiliferous. They have a smooth conchoidal fracture, a fine, compact texture, and take a very good polish; forming an excellent building stone. The beautiful edifice recenly erected at Platteville for a Seminary, is mostly constructed from this stone, obtained from McCord's quarry. No flints are found in the blue limestone.—This rock is often intersected by veins of calc. spar, and cavities occur lined with beautiful crystals of the same substance.—This rock covers but a small portion of the surface, having only a narrow out-crop along the valleys of the streams. Its thickness varies from 30 to 100 feet. It is thickest in the north-west, near the mouth of the Wisconsin, and thins out toward the south and east. It is undoubtedly the equivalent of the blue limestone so abundantly developed at Cincinnati, Ohio; and identical with the Trenton limestone of the New York geologists.

Number 6.

Below the blue limestone, we find a rock differing widely from it in texture and general character. Its ordinary color, where weathered, is light yellow or buff. It is intersected by large fissures, resembling those of the gray limestone. Its fossils are generally casts. It weathers with a smooth, even surface. It is known as the "quarry rock" at Mineral Point, where it has been used in the erection of several buildings. Its usual thickness is about 25 feet, but it thickens gradually towards the east. Believ-

ing it to be identical with the rock represented by Mr. Locke, in a section at Prairie du Chien, and called by him the "buff-colored limestone," I have chosen to retain that name.

Number 7.

Below the buff-colored limestone, sets in a bed of sandstone, from 40 to 100 feet thick. It consists of coarse grains of quartzose sand, cemented together usually with iron and carbonate of lime. Its prevailing color is red, but sometimes it is gray or white; darker and lighter bands frequently occur. The lines of stratification are very indistinct, and sometimes no traces of them appear. It is divided by vertical fissures into immense blocks. Its texture varies from the softness of incoherent sand to the hardness of the most solid rock. This sandstone is thickest in the north, and thins out towards the south and west. It is exposed in the valleys of all the principal streams. At Mineral Point, on the Peckatonica and Blue river near Centerville, and at Pine Bluff, between Mineral Point and Madison, fine out-crops of this formation may be seen.

Number 8.

Next to this sandstone succeeds another limestone—the lower magnesian limestone of Mr. Owen. This rock is exposed only the deepest valleys of the lead district. Its strata vary much both in texture and thickness. In its upper part, intercalations of sandstone occur. The layers are thin, and of a light gray color. Flint, often in angular fragments, sometimes in layers, and occasionally in the form of a silicious oolite, abounds. In some cases a concretionary structure was observed. This was noticed particularly in an exposure of this rock in the valley of the Mississippi, on section 3, town 4, range 6, about two miles above Way's Landing. The concretions are often three feet in diameter, and consist of thin concentric layers of a silicio-calcareous matter. They have been mistaken for "petrified logs." These beds exhibit this con-

cretionary tendency nearly everywhere; though in some cases it is shown only by a waved lamination.

The lower beds are thicker and more massive, much resembling the gray limestone. Small cavities, lined with minute crystals of quartz, called druses, are of frequent occurrence, and are peculiar to this formation. Fissures and joints intersect it. Fossils are rare, and imperfect casts only are found. The precise thickness of the lower magnesian limestone is not known. An exposure of 180 feet is seen near the mouth of the Wisconsin river; and a much greater thickness may be measured north of the Blue Mounds.

I have thus given a brief description of the geology of the lead region. The rocks, whose prominent characters and stratigraphical relations have been described, are the only ones exposed on any part of its surface. They are of great horizontal extent, and can be traced over the whole district, and some of them hundreds of miles beyond; but they everywhere occupy the same order of superposition represented in the sections given. By an examination of these sections, and a careful observation of the out-crops or exposures of the rocks, at different points, almost any person may learn to recognize the various beds of rock wherever they occur. To a practical miner such knowledge is of the highest importance, and a valuable acquisition to every individual. I propose now to treat of the nature and distribution of those deposits of lead ore which have conferred upon these rocks their chief economical importance.

CHAPTER III.

THE LEAD VEINS OF WISCONSIN.

In determining the value of a metalliferous district, the first point to be settled is the mode in which the ores occur. Deposits of metallic ores are divided into two classes: First, those which occur in beds, bunches or veins of limited extent, usually called cotemporaneous deposits. Second, the veins which are defined to be "the mineral contents of fissures having indefinite length and depth." The former are local and irregular, with no constancy of direction, and never extend from one rock to another. The latter, on the contrary, extend vertically to great but unknown depths, and traversing every variety of strata. They may often be traced for many miles in a horizontal direction, pursuing the same general course throughout, and retaining their productiveness, subject only to transient interruptions. They are enclosed between walls of rock, separated from their contained substances by a distinct line of demarkation. The first class of deposits often give promise of a large yield, but fail when pursued for a length of time.—Millions of dollars have been wasted in prosecuting mining operations upon such deposits which seemed to give evidence of exhaustless stores of ore. The experience of the past has taught the necessity of great care in the selection of mining ground; and while it has proved the danger of adventures in those isolated and limited deposits, however rich at first, it has equally established the safety of liberal investments in the exploration of true metallic veins. All mines of the globe, distinguished of permanent value, belong to this latter class. To this class also may be referred most of the deposits of ore in the lead district of Wisconsin. They generally present the characters of true veins, and are therefore

to be treated and relied upon as such. This will be evident, if we examine the general phenomena which they present.

Bearing of the Lead Mines.

The most general direction of the productive veins is east and west. The variation is usually from three to twenty degrees south of east—sometimes, however, it is north of east. Local variations often occur in the general bearing of the lode, but in most cases, if pursued, it will be found to resume its original course. An average of 123 observations upon lodes having an east and west direction, gives a mean variation of eleven degrees from the meridian line.

Another system of veins of less frequent occurrence are termed norths and souths. These vary from true north and south, so that the mean of 40 observations is 14 degrees. In many cases these have a direction nearly N. N. E. Still another class are called quarterings. They intersect the easts and wests at an angle of about 45 degrees; and are often known as "ten o'clock ranges." Besides these, there are strings and branches apparently flying off from the main ranges, and having every conceivable direction.—In a few instances, productive veins (probably by a succession of throws) assume a curved or crescent form, and are hence called "horse shoe ranges." The easts and wests have probably yielded nine-tenths of all the ore raised in the district, and must be regarded as the characteristic or principal veins.

Horizontal Extent of Veins.

Many of these veins are of great length. Several of them have been traced three or four miles, pursuing their general course with such constancy that, when once struck, the compass may be used to discover their location at a great distance. The "Heath-Cock range," in the town of Lindon has been worked for nearly a mile continuously, and its extent for three miles, ascertained qy occasional shafts, which have been sunk upon it. The "Long Range," at Potosi, and the "Great Blackleg" in town 1, range 3

east, have each been worked a mile in length. The breadth of the veins varies from a few inches to 50 feet or more.

Vertical Extent of the Veins.

The depth to which the lead veins penetrate is altogether the most important feature connected with them in a practical point of view. For obvious reasons, it is also the most difficult to be ascertained—as it can be known only by following them into the profound depths of the earth. The deepest shafts yet sunk in the lead mines have penetrated only to the depth of 175 feet. Few even reach 100 feet, and most of the shafts range from 10 to 60 feet. Shallow as these workings are, they have nevertheless revealed many important facts, tending strongly to establish the continuity of the veins to much greater depths. Every practical miner or owner of mineral lands is deeply interested in having this question answered, viz: Do the lead veins continue downwards through the succeeding beds of rock, and carry in their lower portions sufficient ore to justify the increased expense of exploration? To answer this question, so far as could be done, has been made a leading object in the work of the past season. The gray limestone (No. 4, of the sec.) has already been mentioned as the principal surface rock of the lead district. This is the great lead bearing rock of the mines. It has been supposed by many, that the surface rock always carried the ore, and the opinion has been strengthened by the fact that when the veins are followed to the blue limestone below, they uniformaly dwindle and cease to be of workable value. Discoveries of working veins were occasionally reported to me as having been made in the blue limestone, but upon examination I have found them to be located in the lower beds of the gray limestone, which from their bluish cast, are often mistaken for that rock. Mr. Owen also observed this interruption of the veins at the junction of the blue limestone with the gray, and remarks 'that no discoveries of any value have been made below the blue limestone." It is a general law of metallic veins

that they are affected by the character of the rock through which they pass. If they have been very productive in one rock, on passing into another they usually become unproductive, or of no workable value. Mr. WESTGRATH FOSTER in his treatise upon the British Strata, mentions numerous instances of these interuptions. In the mines of Cornwall the veins in descending are sometimes cut off at a change of strata, and after remaining barren for hundreds of feet, again resume their productiveness. In such cases the veins is often followed for great distances, through the barren ground. The practical miner looking with confidence to a resumption of its productiveness, when a favorable change of rock is encountered, and the result generally proves the adventure to be judicious.

By all analogy, if the deposites of ore in our lead district are true veins, traversing rocks similarly various and cut off in the same way, we ought to expect a renewal of their productiveness. That such is really the fact, I hope to be able to prove by the results of long continued and careful observation. The veins cut off by the blue limestone, resume again in the buff-colored rock, (No. 6,) as might be expected according to the law just mentioned.—Such had long been my conjecture, as the ore in the descending veins generally continued strong until at, or just below the point of junction of the grav and blue limestone, where it suddenly dwindled or became dispersed in small cubes through the adjacent rock. The deposites of ore in this lower lead bearing rock, have been worked in a few localities only. At Mineral Point, Dodgeville, Blue Mounds and some other places, these deposites have been reached. At these points, owing to the dip of the rocks, and the wearing away of overlying beds, the buff-colored limestone is found near the surface, and hence easily accessible for mining purposes. Deposites in this rock are known as the "glass rock openings." The glass rock consists of the lower layers of the blue limestone, and is the cap-rock of the openings below. The miners seem in no case to have been conscious of their true geological position, in working these openings. This has been owing in some

measure, to the fact, that in the vicinity of veins the rocks are often so changed, as nearly to obliterate their usual characters. In such cases very careful observation, and some knowledge of the general geology is requisite to intelligent exploration. The buff-colored limestone everywhere underlies the lead district, its depth varying with the altitude as shown in Sec. No. 2. From the erroneous impression that no ore exists beneath the blue limestone, the veins have generally been abandoned when that rock was known to be reached. Hence the lower openings have been discovered only when the rock approached the surface.

The richness of these openings, so far as they have been worked, justifies the conclusion that they will be found equally productive with those of the gray limestone.

The veins which have thus resumed their productiveness, are again cut off by the bed of sandstone, (No. 7.) Not the slightest trace of lead, zinc, or copper has ever been found in this rock, and so extensively is it exposed at the surface, that were it metalliferous, the fact could hardly have escaped observation. In the succeeding rock we might reasonably expect a favorable change. It is the lower magnesian limestone (No. 8,) Its texture is well adapted to the reception of ores, and its position, (being nearer the igneous rocks) is a circumstance favorable to productiveness. From these facts, and from the discovery of small quantities of ore in this rock at its out-crop, Mr. OWEN conjectured that the lower magnesian limestone would be found to contain lead ore in workable quantities. During the past season special attention has been directed to that formation, and discoveries have been made which strengthen that conjecture into certainty. The depth at which this rock lies over most of the region where the lead producing forces are known to have operated, render the investigation exceedingly difficult. In the northern portion of the district, along the Mississippi, Wisconsin and their tributaries, the lower magnesian rock has an extensive exposure. Along this exposure, numerous occurrences of lead in small quantities have been observed, and in one instance a very important discovery of ore has been made. This is

located upon sec. 32, town 7, range 1 east. A branch of Blue River has here worn through the upper rocks and left a terrace of this limestone, rising about 20 feet above the bottom of the valley. During the past season float ore was discovered in the valley, which was traced to this terrace of rock; shafts were sunk, and the existence of heavy bodies of ore was proved. The ore is found in large masses, sometimes weighing 400 or 500 pounds. It is generally in openings surrounded by clay, but is sometimes scattered in crystals among the flints which abound there. The locality is near Franklin and Centerville, where heavy lodes have been worked in the gray limestone. Some ten or twelve miners were at work at this spot when I visited it. Nearly 40 shafts had been sunk, and ore discovered in most of them. Probably 200,000 pounds of ore have been raised from these diggings during the season. The ground is very favorably located for proving the veins to any extent, and it is to be hoped that a mine will be opened here on a scale sufficiently extensive to secure this result.

After these discoveries I can hardly regard it a matter of doubt that the veins continue downward into the lower magnesian limestone. and may be profitably worked in that rock. The addition to the lead bearing ground of the buff colored and lower magnesian limestones is one of incalcuable value, and one which if properly understood and appreciated will give a new impetus to the mining interest of the lead region. Even where these rocks are at the greatest distance from the surface, their depth is slight as compared with that to which mines are worked with profit in other countries. I know of no reason why similar results may not be expected here.

Having thus endeavored to state the evidence bearing upon the vertical extent of the lead veins, to greater depths than have yet been worked, I will now mention some of the leading features by which they are characterized.

Grouping of the Veins.

A vein is very rarely alone, but is usually associated with several others. Among these one is more productive than the rest, and is designated the "champeon lode." On either side of this, smaller veins are grouped like subordinates around their chieftain. This group is known as a "gangue" of veins. Several of these gangues are generally found near each other, and form together what is called the "body of mineral." This assemblage of veins is bounded on every side by spaces which are apparently barren. In passing over the lead region one will notice that the mining operations are all concentrated at a few points. Between these stretch broad expanses, broken only here and there by a solitary prospect-hole. It is important to know whether these spaces are really barren ground, or are only waiting the hand of enterprise to develope their mineral wealth. It is most in accordance with the past history of mining and the known laws which govern the distribution of metallic ores, to suppose that they are collected into groups as they appear to be, and not equally dispersed over the whole district. It is by no means probable, however, that all the spaces apparantly barren are really so. On the contrary we may reasonably expect that rich discoveries will yet be made upon these unexplored grounds. Several experienced miners remarked to me that the bodies of mineral seem to have a north-easterly direction; or, as one of them expressed it, "seemed to throw around towards the north-east." Dr. Percival, the distinguished scholar and geologist whom I had the pleasure of meeting in the mines, remarked a similarity in their shape to the crescent form of the trap ranges, which he had observed while conducting the geological survey of Connecticut. In the disposition of the individual members of the gangue of veins, we observe a very regular alternation, each being placed at nearly the same distance from every other. The gangues are also about the same distance apart. We thus have a serial order in the arrangement of these veins, giving us first, the individual vein; second, the gangues into which the veins are combined, at a

parallel equi-distance; third, the group including these gangues connected by their cross courses into a great net-work of ore, called "the body of mineral." The relation of these veins to each other is a matter of great interest, both in a practical and scientific point of view, and every pains should be taken to collect facts bearing upon it.

Position of the Lead Veins.

The veins of this district present almost every variety of position, but they may be included in two classes, viz:—the perpendicular and horizontal. The perpendicular vein consists of a fissure, having a direction vertical or slightly inclined. It pursues its way downward by a succession of throws, which give it a zig-zag course very similar to its mode of horizontal extension. Its breadth varies from a mere seam to a hundred feet. Sometimes it is entirely obliterated for a short distance, being crossed by a tabular mass of rock, called the "cap rock." Upon sinking through this, an expansion of the fissure occurs, called an "opening." These openings are usually filled with clay, loose rocks, and massive ore. Occasionally, however, they are empty, or partially so, forming caves, whose walls are hung with stalactites. The best examples of vertical veins occur in the south-west portion of the district. At Fairplay and across the Mississippi, at Du Buque, these veins have yielded prodigious quantities of ore. The caves here are noted for the rare beauty of their spars. In some instances they are partly under water, forming subterranean lakes, into which boats have been lowered and voyages taken a hundred feet below the surface. In these caves the ore is generally found attached to the roof and sides, or scattered through the clay which covers the floor. It is rare to find a continuous sheet of ore in these veins. After sinking through the opening the walls come together again, or the veins becomes "pinched," as the miners express it, and yields little or no ore. The miner, however, still continues his work, knowing by past experience that another opening will soon succeed to repay his toil. In many of these

caves the ore occurs partially imbedded in the wall rock on either side in small flat openings or pockets, forming isolated masses. These masses are sometimes of great size, weighing occasionally from 50,000 to 100,000 pounds. Good examples of these broken sheets may be found at Benton, Potosi, Hazel Green and Shullsburgh.

The second class of veins consists of flat sheets, continuous for great distances, and running between the strata, parallel to their plane of stratification. Occasionally, however, they incline downwards or upwards for a few feet, but their dip is very irregular. These flat sheets have been very productive in many localities.—Good examples occur at Mineral Point, Dodgeville, Linden, Messersmith's and Blue Mounds. They are usually connected both above and below with vertical veins. Both these classes seem to have a special geological position. Thus the perpendicular veins, with large openings and caves, are nearly confined to the gray limestone. The middle and lower beds carry flat openings and flat sheets, while flat sheets alone are found in the buff-colored limestone.

"Chunk mineral," "float mineral" and "patch mineral" are broken sheets which have been left by the decomposition of the rock, which once inclosed them, and are now found in the loose material of the surface.

Vein Stones.

In the perpendicular veins, the ore is usually unaccompanied by any of those substances known as vein-stones. The flat sheets, however, are usually associated with some mineral substance, which is the matrix of ore. The most common of these substances are tiff, black jack, dry bone, iron pyrites, ochre, barytes. These accompany the lode, either singly or combined in varying quantities; sometimes filling the entire vein, even, and taking the place of the ore, and at other times entirely absent or very slightly developed. The arrangement of these substances is often in parallel layers, called combs. In such cases the succession is quite irregu-

lar. The ore is sometimes upon one side of the vein, and the vein-stone upon the other, or it runs between the layers of its matrix, dividing often into several branches. In other cases the ore and vein-stone are mingled in one mass, requiring the process of roasting and stamping to separate them. The vein-stones present often a great practical difficulty to the working of mines, by their irregular distribution. In some instances veins have been followed for a distance, and yielded pure ore, but suddenly a vein-stone set in which enlarged until it "eat out the ore," as the miners express it, and the matrix alone remained. This horizontal alternation of the ore and its matrix, has ruined the prospect of many a miner, and in veins thus affected great caution and sound judgment are required. The vein is quite sure to yield pure ore again at some point ahead, but the most profitable method of reaching it depends upon various circumstances. In many cases where this substitution of the vein-stone occurs, the ore is found dispersed through the adjacent rocks in small cubes along the line of the barren portion of the vein. These cubes are often very abundant, and are called "dice mineral." Instances of this character may be found at Mineral Point, Shullsburg, Wingville, Crow Branch Diggings, &c.

It is difficult to determine which of the substances spoken of above, is the most favorable indication of a good lode. Heavy deposits of ore have been found with all of them, or entirely free from any associates, and there is probably no necessary connection between either of them, and the barrenness or productiveness of the veins which they accompany.

I have thus far endeavored to point out the leading characteristics of the lead veins of Wisconsin. I have confined myself to facts without attempting to account for, or explain them. I have endeavored to keep all theories out of view while making observations in the field; the primary object being to find out what is, rather than how came it to be. Both these inquiries are apposite and important, but the first must always be answered fully and truthfully before a reliable answer can be given to the second.

The first, too, is of pressing importance, and its answer replete with practical results, while the latter has only an indirect bearing upon the economical value of the mines. If the miner is familiar with the rocks amid which he is operating, the laws which govern the veins, and the most frugal method of extracting the mineral wealth from those repositories in which nature has stored it; he has knowledge of far greater value than any abstract theory, however satisfactory. With this view, it has been my first object to collect such facts as would illustrate the character and extent of the mineral resources of the lead district, and stimulate their development in the highest possible degree. Still the origin of these veins is a matter of great interest, and ought not to be entirely omitted in this report. I shall therefore present those theories which have been most generally accepted, to explain the formation of metallic veins. Thus every observer will have before his mind what others have concluded upon this subject, and be enabled to decide for himself how far these views harmonize with the facts of which he is personally cognizant.

CHAPTER IV.

FORMATION OF VEINS.

The filling of mineral veins is one of the most difficult subjects in the whole range of geological studies. The more careful the investigation, the more fully aware is the student of the difficulties to be overcome. It is now quite generally admitted among geologists that several processes have been active in supplying veins with their metallic contents. There are four theories, each of which has been sustained by high authority, and all of which are undoubtedly true in their practical applications. First, The crevices or fissures are supposed to have been formed, and mineral matter, dissolved in water, to have been filtered into them from above. This theory was maintained by WERNER, but it probably applies to very few cases of veins. Second, The metallic ores are supposed to have been melted and injected into the rocks by subterranean forces, similar to those concerned in the protrusion of lavas through volcanic craters. Many veins have undoubtedly been filled, as they may often be traced to a mass of rock which has once been lava. Of this kind are the tin and copper lodes of Cornwall, England. This theory was first taught by HUTTON, and has been very widely adopted. Third, Another theory is that of sublimation, or the introduction of the metals in the state of heated vapor, which, upon cooling, condensed and formed veins. It is a well known fact that metals can be vaporized by heat, and that when in this state they naturally ascend and condense upon cooling. Crystals of galena, specular iron ore, and other metals, are thus formed in the laboratory, in the flues of furnaces, and the craters of modern volcanoes. Similar processes have no doubt been operative in all pe-

riods of the earth's history, and must have produced similar results. Fourth, Electro-chemical action is supposed to have been exerted, causing a segregation of metallic particles, and thus forming veins. The superior productiveness of the east and west veins is accounted for by the greater facility with which the segregation could take place from north to south, on account of a coincidence between the local and general currents of electricity. It is supposed that by this action constant decompositions, re-compositions, and transmissions are being effected. A wide variety of opinion exists among practical miners upon this subject. All these theories have their advocates, each basing his opinion upon the special and local facts which he has observed. The theory of formation from water is stoutly maintained by many who have seen the ore pendant from the roof of caves, associated with stalactites which are known to have had such an origin. But it is quite certain that this opinion is incorrect. The insolubility of galena in water, its crystaline character, and arrangement in veins, are all incompatible with such a supposition. If we take any one of the other theories mentioned, it fails to explain all the phenomena presented; but each receives support from some of the peculiarities which these veins exhibit.

It is not improbable, therefore, that each of these processes has been in some degree instrumental in producing and arranging these deposites of ore. They may have acted cotemporaneously, or successively, or in both methods.

In the lower deposites, generally arranged in flat sheets, we often find evidences of a highly heated condition of their contents. The rocks enclosing the vein are often harder and more crystaline than those at a distance. The ore and its vein-stone are sometimes intimately combined, resembling in texture the coarse granites and other rocks of igneous origin. In some parts of such veins a segregating force seems to have acted, separating these ingredients, or some one of them into layers, precisely resembling the veins of segregation so often seen in the igneous rocks. Almost every grade of texture may be observed among these vein-stones, as

among different beds of granite, sienite and porphyry. These are entirely confined to the lower deposites, so far as my observation extends. The perpendicular veins carry pure ore, as before mentioned. This ore is attached to the roof, and side walls of their cavernous openings, but is rarely found in place upon the floor of the caves. If we suppose the fissures to have been open and the ore injected into them, such an arrangement could not have taken place. The fissure would be either completely filled in such an event, or its lower part only, occupied by the ore. It is far more in accordance with the phenomena to believe that the perpendicular veins were filled by the process of sublimation. The heat, which perhaps melted the lower flat sheets, might be sufficient to vaporize a portion of the galena, which passing upwards into the vertical fissures, would condense and arrange itself in their upper portions, as we find it now. The absence of vein-stones in these veins is accounted for by this theory, as the lead ore would be volatilized and carried upward, at a much lower temperature than its associates.

Another interesting evidence of vaporization, is the occurrence of the casts of fossils formed by the introduction of Galena into the cavities of shells, corals, &c., The tubes of delicate corals, sometimes scarcely larger than a hair, are occasionally found filled with the ore; and also the stems of encrinites. I have also a specimen of crystalized galena, which has been formed in and around a mass of fossil shells, that have evidently been first worn by water to mere comb. The ore had then been introduced among these delicate remains, and received the impressions of its constituent shells. Evidently, in these instances the galena must have been in a state of very minute division, and endowed with perfect freedom of motion; conditions which could only be realized by its vaporization. In the absence of sufficient data to warrant a conclusive opinion, I have stated the prevailing theories, and such applicacation of them as seemed most in harmony with facts. From the desultory and irregular manner in which the mines have been

worked, it is very difficult to collect facts upon the most intricate points presented in these veins. The observations made may serve as a nucleus for future facts and discoveries, which in due time, if faithfully gathered, will point out the true theory of their formation.

CHAPTER V.

SURFACE INDICATION OF LEAD VEINS.

There are various indications of the presence of lead veins, all of which are more or less reliable. The general character of the ground is first noticed. A surface cut by frequent ravines, or presenting longitudinal depressions is always preferred, as these indicate the existence of fissures in the rock below. The discovery of "float mineral," or more properly "shovel mineral," is reliable evidence that a vein exists at no great distance from which the scattered ore has been separated. It is usually found in vallies on the sides of slopes, or in beds of clay upon the level surface.

Scattered pieces of tiff, or vein-stones of any kind, are good indications of the same nature as that just mentioned. The growth of vegetation in a linear direction, is also relied upon, as pointing out the location of a crevice which may hold "mineral." Certain plants which thrive best in deep soil, choose such locations as furnish the greatest depth of soft ground. Along the line of the veins their deep reaching radicals meet with no obstruction. Hence, lines of rank vegetation often form a prominent object among the surrounding growth, and mark the location of fissures in the rocks beneath. A notion prevails very widely that a certain plant, known as the "masonic" or "lead weed," grows only where its roots are fed by lead ore. This plant is noted for the depth to which its radicals are known to pierce. They are often found from 40 to 60 feet below the surface. It is therefore usually found growing over crevices where its subterranean proclivities can be indulged without restraint. This indication is said to have been learned from the Indians, who used it long before the lead

veins of this district were known to the whites. These are the ordinary tangible evidences upon which the miner relies in "prospecting." They are fonnded upon the well known relation of things, and experience has proved their genuineness. Certain other processes of discovery are practiced by some. The use of various forms of the "divining rod" is the most common of these.—From its cheapness and simplicity, it is within the reach of all, though it refuses to exert its enchantment except in favored hands. An instrument called a "tinkembob," much more expensive, but also said to be more reliable, is occasionally met with. As these methods of discovery are entirely arbitrary in their character, and have no reference to the truths of mining science, they are beyond the jurisdiction of my present investigations, and in the absence of all positive knowledge, I cannot venture an opinion upon their practical value to the explorer.

In prospecting, a general knowledge of geology would be of great service to the practical miner.

Untold thousands of money, and long years of toil have been wasted for the want of such knowledge. The lead region is covered with "prospect shafts," sank where the veriest tyro in geology would have pronounced an unconditional negative upon the hope of "striking a lead." The adventurous swarms of "prospectors" who sweep over the mines during the excitement of first discovery, left few of the surface veins unopened. Hence, prospecting is now attended with great risks, and requires superior sagacity and extensive knowledge for its successful prosecution.

CHAPTER VI.

WORKING OF THE LEAD VEINS.

It is quite certain that the existence of lead ore had been known to the Indians, long previous to the commencement of mining by the whites. Their ancient works still remain to attest the fact. These consist of shallow diggings, and wide furnaces in which the ore was smelted. The natural sagacity of the Indians made them successful prospectors, but, destitute of tools or skill in operating, they seem to have made slow progress in proving their discoveries. Their working consisted mainly in picking over the soft clays of the surface, or the larger crevices with hatchets rude sharp sticks. When their shafts became a few feet deep, and ladders were made by cutting off the branches of small trees, about a foot from the trunk. Upon these the squaws, who performed all the labor of mining, descended and ascended, carrying in bags and baskets, all the ore which they obtained. These rude ladders were occasionally found among the old "Indian diggings." In some cases they ran levels a short distance into the sides of the hills, upon veins which they had discovered, using mats and blankets as sleds to draw out the rubbish. Where the vein entered the solid rock, they made fire upon it, and when heated, poured on water, by which it was cracked, and rendered easy of removal. Their metallurgy was equally rude and simple. A rude hopper was built of stones, usually upon the side of a ravine. Into this the ore was thrown and a fire kindled beneath. When melted, it was run off into a hole dug for its reception.

Such rude attempts at mining seem to have been made, previous to any acquaintance with the whites. Later, however, the

French traders furnished the Indians with tools, and instructed them further in the art of mining. They also purchased their ores, and gave them in exchange, such articles as they required. This stimulated them to farther exertion, so that from 1816, to 1820, considerable quantities of ore was raised by them, which was sold to the traders and found its way to St. Louis. American mining commenced about 1820, but no considerable amount of ore was raised until about 1827. The lead region then began to attract popular attention. A few bold pioneers were already in the mines, and amid all the perils of Indian warfare, remained. As soon as the war closed, they recommenced their mining with renewed vigor. The fame of their discovereies went abroad, and brought to the mines thousands of adventurers, who swept over every hill and valley in search of the mineral treasures they were reported to hold. Brilliant discoveries were made, and splendid fortunes acquired. The ore lying near the surface, was of course first found, and requiring little skill to secure it, mining was exceedingly simple. No machinery was needed for draining, and no large outlay of capital was required to insure returns. Under such circumstances, no regular or systematic mining could be expected. Every man was a prospector and preferred breaking ground for a new lead, to working for wages, or moderate returns, in ground already proved. During the twelve years, from 1830 to 1842, machinery was hardly thought of. It was the period of excitement and discovery which always attends the opening of a new mining district. Since that time, very few new discoveries have been made, and the work has been mostly confined to old lodes. With few exceptions, even now, the mines are very ineffectually worked. The shafts have been sunk with no view to permanence. Drifts are run off from them wherever indications of ore appear. If the ground is soft they are supported by temporary cribbing. The rubbish and ore are raised by a common windlass, in wooden tubs called "kibbles." The digging generally ceases at the water line. If however, the vein is strong enough to warrant it, a lifting-pump worked by horses or oxen, is put in.—

In a few instances only, steam power has been used in working pumps; but from the incapacity of the engines, or injudicious management, it has failed to be profitable. During the present season two engine pumps have been started under more favorable auspices. One at Potosi, by Mr. Lewis, and the other at Fairplay by the American Mining Company. Both these parties have ample means at their disposal, and are determined to make a fair experiment. Water-power has been used in one or two instances, and might be profitably employed in numerous localities. With these exceptions, all the labor of the mines is performed either by hand or horse power.

CHAPTER VII.

PRODUCTIVENESS OF THE MINES.

In order to exhibit properly the condition and value of the mining interest of the Wisconsin Lead District, I have carefully collected from all sources within my reach, such statistics as could be obtained, and am enabled to present a table, showing the annual productiveness of the lead mines, during most of the period since 1823. The product for the first seven years, from 1823 to 1830, I extract from the report of Dr. OWEN, made to the general government in 1840. The remainder of the table was supplied by Capt. CHARLES BEEBE, of Galena, whose acurate habits entitle his statistics to the fullest confidence.

A TABLE

Exhibiting the amount of Lead shipped from the Lead District of Wisconsin, Illinois, and Iowa, from the year 1823 *to* 1853, *inclusive.*

YEAR.	POUNDS.
1823	335,180
1824	175,320
1825	664,520
1826	958,842
1827	5,182,180
1828	11,105,810
1829	13,343,150

Here follows a period of eleven years, for which we have no statistics, owing to a change in the mining regulations.

1841	31,696,980
1842	31,653,330
1843	39,148,276

Years.	Pounds.
1844	43,729,540
1845	54,497,860
1846	51,368,210
1847	54,634,450
1848	47,737,830
1849	44,605,380
1850	39,801,130
1851	33,188,056
1852	28,703,960
1853	29,806,980

From this table it will be seen that the annual yield of the mines went on increasing to 1845, when it attained its maximum, and remained nearly stationary for three years. From 1848 forward, a steady decline is shown, bringing us by a constantly decreasing series to a product nearly fifty per cent. less in 1852 than 1847. A decrease so marked and rapid in the productiveness which had been constantly increasing for thirty years, proves the operation of some powerful and wide-spread cause. This cause it is highly important to ascertain and make known, for in the absence of authentic knowledge, serious misapprehensions exist abroad in regard to its true nature. It is generally supposed that the deposits of lead are nearly exhausted, and therefore hold out no inducements to business men to engage in working them. Hence, while capital has been freely flowing to other mining districts far less rich in metallic ores, no non-resident company has ever made an investment in the lead mines of Wisconsin. Unfounded in fact as this report may be, it has nevertheless done much to injure the mining interest, and at this time exerts a strong influence against it. The real causes of this diminished product are well known to those familiar with the history of our lead mines.

First, while the mines were at their maximum productiveness, the discovery of gold in California was announced, and drew off one-third of the whole mining force. This was a loss that could not be replaced, especially while the whole tide of adventurous emigration was flocking to the land of gold. The following ex-

tract from the Shullsburg *Pick & Gad* presents the conviction of all who are acquainted with the loss thus experienced:

"Although science may do much in developing our mines—a scientific research bring out and establish new principles—yet we feel that if we had among us that population which opened the diggings which we are now working,—if we could call back from California some of those enterprising young men who have left within the last four years,—could we gather up the bones of those brave miners that are bleaching upon the far-off plains of Mexico, and re-animate that dust which is mingling with the ashes of the Aztec,—could we people the mines with the population of '40 and '46—we would again hear the cry of new diggings, new lodes, new towns, and a change would come over the spirit of this dreaming, gophering community, which, with a few exceptions, are drifting around and picking up mineral upon the discoveries of those brave boys who were always in quest of new things."

As a second cause, the prevalence of an irregular and inefficient method of working the veins may be mentioned. This has already been described in a former paragraph. Such working answered well enough as long as there was surface ore enough to pick up; but when the superficial deposits were exhausted, it was inadequate, and a falling off in the product could not fail to follow.

The mines have been worked entirely with a view to immediate results, and generally by single individuals, or small and temporary combinations, with little capital at their command. The working of veins at any considerable depth involves an expenditure too large for any except companies with heavy capital. The reason will be seen at once, when the nature of the operation is considered.

In following a vein, dead or barren ground is often encountered, as already noticed, and the miner must work through these unproductive portions in order to reach the deposits of ore. The distance that he must work without receiving any returns is uncertain, but it is quite sure that somewhere before him, the vein will resume its productiveness. The constant hope of discovery stimulates him to effort, and not unfrequently poverty and want spur his limbs to the uncertain task. After years of toil, he perhaps strikes a lead,

and is repaid for all his sacrifices; or, as not unfrequently happens, worn out in body, discouraged and beggared, he abandons his shaft forever. Another miner, bringing fresh energy and capital, steps into his place, and taking up the work where he had been compelled to leave it, soon finds an opening which yields a competency or a fortune. In some cases, shafts or drifts have been worked by several sets of miners successively, and abandoned by each, where at last some fortunate individual comes in, strikes a lead, and alone reaps the reward of their united labors. The history of these adventures would furnish instances of manly fortitude and persevering toil which have never been surpassed. We know those who have succeeded; but the long, sad catalogue of those who failed, is lost in the obscurity of poverty and the grave. Such experience proves that the risks of mining are too great for single individuals with small capital, and very few can now be induced to attempt it, who thoroughly appreciate the small chances of success.

The system of individual mining is also a serious obstacle in the way of drainage. Owing to the limited size of individual claims, one mine often cannot be drained by a pump or level, without receiving the water from several others belonging to various owners, and unless some arrangement can be effected among them, the ground remains unworked, for no one would be willing to bear the whole expense of drainage where all are to share its benefits.

The development of the mines has also been retarded in some localities by the illiberality of non-resident land owners, who demanded exorbitant rents, and desired to throw all risks upon the miners. Many rich lodes have been left unworked, to the damage of the owners, as well as other parties interested.

Under these depressing circumstances, mining could not long be profitable in any district, and we are not surprised that our mines have diminished their product one-half in the last five years. Suppose such a system tried in the metalliferous districts of Britain and Germany. Would not their great metallic arteries, which now flood the markets of the world, dry up, or shrink into insignificance?

Mining, like manufacturing, requires for its successful prosecution, systematic, comprehensive, and long continued application of labor and capital. Individual mining can be profitable only for short periods. It lacks the force, and has not power to avail itself of the economies essential to success. Individual interests and capital must be combined and brought under the influence of a common aim. Risks and benefits must be shared, force must be organized, and guided by intelligence and skill; then nature can be conquered, the difficult problem solved, and the gate of her stony treasuries opened in triumph.

The mines are now in a transition state. They have passed through the period of excitement, when chance rewarded the fortunate with rapid gains, to a more quiet and settled condition, in which rude and individual attempts at mining are attended with frequent failure and occasional success. They now await the period of organization to which their full treasures are to be surrendered.

CHAPTER VIII.

VALUE OF THE LEAD MINES OF WISCONSIN, AS A FIELD FOR EXTENSIVE MINING OPERATIONS.

In opening an extensive mine, a large expenditure must be made before any return can be realized, it is therefore important to calculate closely beforehand the conditions required to render this preliminary investment a profitable adventure. This involves several considerations, each of which must have its due weight in determing the value of a mining locality.

First—The character of the metalliferous deposits.

Second—Extent of unworked ground, where discoveries of ore may reasonably be expected.

Third—Character of the ground.

Fourth—Facilities for drainage.

Fifth—Proximity to fuel, market, &c.

Let us now see how the lead region of Wisconsin will abide the test of these conditions.

First—Character of the deposits. I have already shown that most of them are true veins and may be relied upon as such in extensive mining operations.

Second—Extent of unworked ground. It has also been shown that the works thus far have merely been superficial. The deposits of the surface rock even have only been exhausted in a few cases, while those of the lower rocks have but just been discovered. All the mining thus far done could be put upon six sections of land. Veins are everywhere pointed out which have been abandoned, though still yielding richly, for want of machinery to remove the water, or from the occurrence of a temporary "pinch" which cut

off the ore. The constant discovery of veins incidentally while digging wells, cellars, &c., proves conclusively that a vast addition to the known mineral ground may be looked for in this direction; while the unexplored deposits of the buff-colored and lower magnesian limestones, offer a fresh and promising field to mining enterprise. From those rich storehouses of ore, generations to come will draw their supplies and leave them yet unexhausted.

Third—Character of the ground. This is eminently favorable. The veins intersect only limestones, sandstones, and shales. No injections of trap or granite occur here, which so often ruin the prospect of the miner elsewhere. The rocks have been very slightly disturbed, hence faults or shifts of the strata, throwing the veins out of their natural position are rare. The ground is frequently so open that nothing but the pick and gad are required for excavating it.

Fourth—Facility of drainage. As most mineral veins run into the water at a short distance from the surface, it is important to know with what facility this element can be removed. This will depend upon the structure of the rocks and the conformation of the surface. Near many of the lodes the surface is intersected by deep ravines and vallies, on either side of which the lead bearing rocks are piled. In such cases drainage by level can be very easily effected. This method of drainage has advantages over every other where it can be used. As the veins are arranged in gangues, parallel to each other, a level may be run so as to cut them all in its course and thus prove the ground at the same time it relieves it of water. Such a level, judiciously located and perseveringly driven could not fail to enrich it owners. Numerous localities might be selected, where by running a level one mile, from twenty to fifty veins would be cut through and drained. A few levels only have been undertaken. That of Mr. CHAMPION at New Diggings is the most extensive, and has been eminently profitable.—Mr. LOONEY'S level, near Benton, has been driven 900 feet, and paid well. McCOY'S level, near Shullsburg, is also a good invest-

ment. These are only beginnings, but they prove what may be done in this direction.

In Europe, these levels are often driven for many miles, at an expense of from five to twenty dollars per fathom. One of these levels, at the Gwennap mines in Cornwall, is twenty-six miles in length.

The lead mines of this district can also be readily drained by pumps of moderate capacity. The lead-bearing rock is traversed by vertical seams, filled with a tough clay impervious to water. By this means, the water which it holds is divided into separate basins, or great natural cisterns, each independent of every other. Thus, a pump may be put upon any one of these, and unwater the ground within its limits, while those adjacent are not affected. Were it not for this beautiful economy of nature, no pump could be found of sufficient power to lower the level of these subterranean waters. This structure also explains the fact, that the water is often found twenty or thirty feet higher upon one vein than upon another a few rods distant. In some cases, the basins are so small that forty feet of water has been raised by a pump of three-horse power. In other cases, fifty-horse power would be required to effect a thorough drainage.

Fifth—Location in respect to fuel, market, &c. The lead district as a whole is abundantly supplied with fuel, though in some few localities, wood has to be brought from a distance. The dense forests of its river valleys, and the heavy bodies of oak and other timber which cover nearly one-third of its surface, promise a store of fuel amply sufficient for its future wants. The great coal field of Illinois is scarcely a hundred miles from its southern border. Lines of railway, traversing it from east to west, and from north to south, will soon connect it with those vast stores of combustible matter, and disperse the spoils of its own forests wherever the wants of industry may require them. It is thought that under these facilities for cheap transportation, coal may be afforded at $2,50 per ton. At this price, it could be safely used in those

portions of the district where wood is least abundant. The completion of the railroads, now being rapidly constructed through this district, will give it, together with its proximity to the Mississippi, ready access, at every season of the year, to all the markets of the country.

I have thus endeavored to set forth the character of the lead mines of Wisconsin; the causes which have obstructed their development; and the inducements which they offer for extensive mining operations. It has been shown that the deposits of ore are true veins; and unexhaustible for centuries to come. That as yet they have been worked only in the most superficial manner; that the withdrawal of labor into other fields, the want of concentrated capital, and the prevalence of mistaken opinions as to their value, have all been operative in retarding their progress, and bringing their productiveness to a temporary decline. Yet even under these unfavorable circumstaaces, these mines yield annually nearly 30,000,000 lbs. of pure lead, or about one-half of all the lead produced in the United States. During the years 1845, 1846 and 1847, the entire lead mines, including the small portions of the district in Illinois and Iowa, produced annually about 54,000,000 lbs., of which two-thirds were from the Wisconsin mines. During the same years, the average annual yield of all the lead mines of Great Britain was 105,736,333 lbs. The yield of our lead district, therefore, exceeded one-half of the total product of the British lead mines. Such a product of ore, with the some outlay of labor and capital, is altogether unprecedented in the whole history of mining.

During these years, lead became an important item in our foreign exports, while the import of this article sank to a mere trifle. This will be seen by consulting a few statistics from the records of trade. During 1845 and 1846, the imports and exports were as follows:

Imports.	*Rec'ts at New Orleans.*	*Exports.*
7,995 lbs.	54,930,000 lbs.	16,823,766 lbs.

In contrast with these figures, observe the same statistics for the last two years—1850 and 1851:

	Imports.	*Rec'ts at New Orleans.*	*Exports.*
1850–51—	43,490,000 lbs.	22,750,000 lbs.	227,448 lbs.
1851–52—	37,544,588 "	18,729,580 "	747,930 "

According to these figures, in the years 1845 and 1846, we not only supplied our home market with lead, but sent to foreign countries 16,000,000 lbs. While during 1850, '51, and '52, we have fallen so far short of supplying our home market, that we import annually 40,000,000 lbs. to make up the deficit. For this we send out of the country annually, about $2,500,000 for a commodity which might be abundantly supplied at home. Two-thirds of this sum of money sent away to pay the miners of England, Germany, and Spain, ought to be laid out in the lead mines of Wisconsin, and would be, if these mines were worked to an extent at all commensurate with their inherent richness. It is obviously of the highest importance that an interest like this, second to no other in our State, should not be suffered to decline. At this period especially, when we are just setting up for ourselves, we need the avails of those natural resources with which a beneficent Providence has favorved us. If our young State would become rich in acquired possessions, it must improve this fundamental capital. It should buy much, but sell more, and buy nothing abroad that it can get at home. What a transformation would the vast sums now sent abroad for lead accomplish, if distributed over our lead district, for which nature has done so much, and art so little.—What engines would pump its deepest mines! What mighty levels would be cut through the walls of its veined treasuries!—What life would be infused into every branch of industrial effort! What cities would grow up as if by magic; and what evidences of wealth and prosperity would cover all the land! For such a consummation, a little fostering care only is now needed. The true value of these mines must be made known; and companies with ample capital must be found to work them. A Department of Mines, similar to the School of Mines in Great Britain, should be

connected with the State University, where such scientific knowledge as is necessary for successful mining, may be obtained.

Under the present high prices of lead, the mines are reviving, and it is to be hoped that no change of governmental policy will result in a reduction of these prices until they are again in a state of healthy activity.

CHAPTER IX.

ZINC ORES OF WISCONSIN.

These ores (popularly known as "black-jack," and "dry-bone,") are found in quantity in the lead district. They are generally supposed to be worthless, and hence are thrown away among the rubbish of the mines, no thorough attempt having been made to ascertain their value or to reduce them to use. Impressed with the importance of ascertaining their true quality, I have caused them to be thoroughly examined and analyzed, with a view to determine their workable value. The experiments thus far have been made with the dry-bone, as the black-jack is better known, and from its peculiar composition is a less valuable ore, being practically valueless here, from the great expense attending its reduction.

The examinations were conducted by Dr. AUGUSTUS HAYES, of Boston, whose distinguished reputation as a chemist, and large experience in the assay of similar ores, will inspire the fullest confidence in the correctness of his results. His report upon the zinc ores submitted to him, is given below, and shows that this dry-bone contains from 79 to 90 per cent. of the oxide of zinc, four-fifths of which is pure metal. This large per centage of metal is so favorably combined as to be readily separated by known processes from the ore.

The examinations were conducted at my request, with especial reference to the capacity of the ore to yield the white oxide of zinc, which, from its great value as a pigment, is becoming an article of the highest importance in the market. The results are of the most favorable character, proving the existence of a new source of mineral wealth in this district, second only to its won-

derful lead veins. The oxide of zinc, or zinc white, is now rapidly superceding white lead as a paint, owing to its quality, absence of poisonous effect and greater cheapness of production.

To supply the great and constantly increasing demand for it, we have in the United States only two manufactories: one in New Jersey and the other in Pennsylvania. The New Jersey works have been in operation about three years, and have prepared their paint from the red oxide of zinc, which, until recently, was supposed to be the only ore capable of yielding zinc white, without first reducing it to a metal. A recent discovery however, has been made, which proves this supposition to be an error. An ingenious metallurgist, SAMUEL WETHERELL, Esq., has discovered a process of manufacturing this article from the dry-bone or carbonate of zinc. The Pennsylvania works have been erected for the purpose of applying this discovery upon an extended scale, to a deposite of dry-bone discovered and owned by SAMUEL SMITH, Esq., of New York, to whose enterprise, and that of Mr. WETHERELL, the public are indebted for this important addition to the available resources of the country. The works have just been completed and commenced operations. An extract from the American Mining Journal will show the success of the invention in practice:

"The assertion that the oxide of zinc could not be made from the calamine, (dry-bone,) unless by first reducing the zinc to a metallic state, and then sublimating it, has been proven, within the present week, untrue. This fact is not merely the result of analytical experiments, but is daily accomplished, making four tons of oxide of zinc, or twenty-four tons per week. We learn from an officer of the company, that they will at once proceed to enlarge their works and increase their product to ten tons per day, or 3000 tons per annum. This at $130 per ton, would amount to $396,000, which, ground in oil, would sell for $180 per ton, or $540,000 per annum. These estimates may be relied upon as demonstrated by the actual working of the manufactory. The

white oxide produced by this process will compare favorably with the best French white, besides being superior to it in body."

Dr. HAYES has shown that our ores are fully equal, if not superior, to those of Pennsylvania. They are found in sufficient abundance to supply extensive works with raw material. They could be obtained very cheaply, both on account of their frequent association with lead veins, and the quantities already thrown out upon the surface, in mining for lead. They are within 150 miles of Milwaukee and Chicago, to which points they will be connected in one year, by railway communication. To these places they could be conveyed at a cost of $1,50 or $2,00 per ton. If preferred, coal could be transported inland at corresponding prices. Every ton of ore will yield from 1400 to 1600 pounds of pure white oxide. This could be sold at the door of the factory for $130 per ton. The cost of the ore and manufacture would not exceed $60 per ton, leaving a clear profit of $70 upon every ton of the oxide manufactured. A factory producing ten tons of oxide per day, would thus yield to its owners a net annual profit of $210,000. This is no fiction. These results are realizable, and will be realized, when capital, enterprise, and skill are organized and brought to bear upon this new branch of our natural resources. The manufacture of metallic zinc and brass might also be profitably conducted with this ore. For this purpose it is the best ore known, and is used in Europe in preference to any other. All of our zinc and most of our brass is now imported, while our mines of zinc and copper are second to none in the world. We need only patience, skill, and confidence, to conquer the slight difficulties which now lie in the way to these great sources of wealth and prosperity, with the means of which we are so abundantly provided. I commend attention to the accompanying report of Dr. HAYES.

REPORT OF DR. AUGUSTUS HAYES, UPON THE ZINC ORES OF WISCONSIN.

To Edward Daniels, Esq.,

Geologist to State of Wisconsin.

Dear Sir:—I am able at this moment to send you the results obtained by chemical analyses of the ores of zinc, which were among the valuable ores and minerals you placed in my hands:

No. 11 of the series. (Dry-bone diggings, near Shullsburg.) The specimen is a carbonate of zinc, with accidental portions of carbonates of lime, iron, and manganese.

One hundred parts of this ore consist of

Pure oxide of zinc,	59.76
Oxides iron, manganese, and lime,	4.84
Earthy matter, or rock,	1.40
Carbonic acid and water,	34.00
	100.00

One hundred parts of this ore, after roasting or heating to redness, contain 90.50 pure white oxide of zinc.

No. 12 of the series, from Platteville. The specimen is a carbonate of zinc, with a little silicate of zinc and carbonate of lime.

One hundred parts of this ore consist of

Pure oxide of zinc,	60.20
Silica and oxide of iron,	2.20
Carbonate of lime,	12.60
Carbonic acid and water,	24.00
Earth or rock,	.40
	100.00

Specimen No. 12.—One hundred parts of this ore, after being heated to redness, contain 79.20 of pure white oxide of zinc.

No. 13 of the series, from Mineral Point.—This specimen closely resembles No. 12, consisting of carbonate of zinc with rock.

One hundred parts consist of

Pure oxide of zinc,	56.20
Oxides iron, alumina, &c.	1.80
Carbonate of lime,	2.00
Silicious rock,	6.60
Carbonic acid and water,	33.40
	100.00

One hundred parts, after heating to redness, contain 84 3-10 parts of pure white oxide of zinc.

No. 14 of the series, from Mifflin.—Carbonate of zinc, with some earthy matter.

One hundred parts consist of

Pure oxide of zinc,	57.00
Oxides iron, alumina, &c.,	5.40
Earthy matter,	7.60
Carbonate of lime,	2.00
Carbonic acid and water,	28.00
	100.00

One hundred parts of this ore, after having been heated to redness, contain 79 1-10 parts of pure white oxide of zinc.

No. 21, of the series, from Messersmith's, near Dodgeville.—This specimen is also a carbonate of zinc, mixed with earthy matter, mostly silicious.

One hundred parts of this ore consist of

Pure oxide of zinc,	56.20
Oxides iron, alumina, &c.,	2.80
Carbonate of lime,	1.80
Silicious rock,	6.20
Carbonic acid and water,	33.00
	100.00

One hundred parts of this ore, after having been heated red hot, contain 83 9-10 parts of pure white oxide of zinc.

The value of white oxide of zinc as a pigment, is becoming generally known, and it has a market price much higher than white lead. Most of the metallic lead consumed for paints is first made into white lead, which thus becomes the staple manufacture

based on metallic lead. Now these ores of zinc, familiarly known as "dry-bone," are the best ores for producing the white oxide of zinc; but the manufacture is not here based on the metal, but on the ore. By merely heating these ores in heaps on brush-wood, they lose their carbonic acid and water, and become soft mixtures of from 79 to 90 per cent. oxide of zinc, with earths and iron oxide. The material thus obtained, mixed with charcoal, gives in the muffle furnaces, by one operation, nearly all the oxide of zinc which the ore contains. Extensive manufactories can be sustained by the consumption at present going on, of this product, which continues to be imported largely. But these ores are equally as well adapted to the production of metallic zinc, a very useful metal, bearing a higher price than lead. The ores used abroad for the production of this metal, are far inferior to these in quality, and they are not extensively distributed. On economical considerations, therefore, these ores have a high value. They offer the advantage of employing a large capital with a certainty of the manufacture being profitable and important. A state possessing such mineral deposits, must be regarded as rich in resources of a highly important kind.

Respectfully,

A. A. HAYES,

Assayer to State of Massachusetts.

16 Boylston St., Boston,
31st Jan, 1853.

CHAPTER X.

AGRICULTURAL CAPACITY OF THE LEAD REGION.

The best mining districts of the globe are generally noted for their sterility. This is not, however, always the case; and indeed there is no necessary connection, between metallic ores and unproductive soils. But the igneous rocks with which these ores are very generally associated, and the broken surface which accompanies them, are unfavorable to agricultural pursuits. In this region, however, we have no igneous rocks exposed, and the surface is generally only slightly undulating.

The soil is generally a rich, calcareous, and silicious loam, with a sub-soil of clay. In the north and east, where the sandstone comes to the surface, patches of sandy soil occur. Its fertility is attested by the actual results of farming whenever attempted—a testimony far more tangible and satisfactory than could be given by any analysis, however complete. The most abundant crops of wheat, corn, oats, rye, barley, potatoes, &c., are returned to the farmer. Fruit trees of every variety known in our northern latitudes, thrive vigorously and bear abundantly. Some of the producing orchards of this region cannot be surpassed in the country. Even the grape seems at home, and ripens finely in the dry, pure atmosphere peculiar to our State. Tobacco and flax thrive wherever tried. The traveler who passes over this region, when the crops are waving in the luxuriance of summer, and the orchards bending beneath their fruitage, will need no aid from the geologist and chemist to convince him that its soil is of the best quality.

Living water is abundant here. Springs gush out from every hill-side, and streams flow in every valley, whose crystal waters are equal to any that the poets have ever feigned or sung. Thus

water for stock can be easily obtained—a prime consideration in the selection of a farm. The streams are generally rapid, and furnish excellent water-powers for milling and manufacturing.

Timber is also abundant, with the exception of a few large prairies; yet even on these there are no points more than three or four miles distant from the wood. An interesting and valuable feature may be mentioned in this connection, viz: The rapid growth of young trees from the soil of the open prairie, wherever the annual fires are shut off. Upon Judge BLACKSTONE's farm, near White Oak Springs, we were shown dense groves of young trees, from six to ten inches in diameter, where, twenty five years ago, not a shrub could be found larger than a riding whip. The same process may be seen in numerous localities, at various stages of advancement, from the prairie, covered with sprouts of oak, hickory, aspen, hazel, and sometimes maple, linden, and ash, to thick groves which have been growing for many years. In what manner have the germs of these trees been preserved in the soil of the prairies from which they spring, during the long period that they must have remained dormant? If proper precautions are taken to protect the surface from the fires, every farm upon these prairies will supply itself with timber in a few years. No uneasiness need be felt in regard to wood in this district, as the growth will far more than replace the use, and self-interest will dictate the preservation of young trees.

Its proximity to the great pine regions of the north, renders lumber cheap, and easily obtained. Its location, in point of access to market, with the Mississippi on the west, and about to be connected by three lines of railway with the east, cannot be surpassed. It possesses every needed facility of communication to give a good market for its agricultural products. The home demand now absorbs whatever the farmer can raise, at high prices. The prices of lands are very low, considering their quality and location. Here, then, we have in the lead mines every essential to the successful prosecution of agriculture; a fertile soil, wood, water, timber, and a ready market at home or abroad for every thing pro-

duced; a fine climate, and cheap lands. We may justly claim for this district agricultural resources equal to any other in the great valley of the Mississippi.

We can safely commend it to the agriculturist who is seeking a location. Laboring under mistaken ideas of its character, regarding it as dry, sterile, and broken, the tide of agricultural emigration has swept by, to lands inferior in quality and far less favorably located. Let the emigrant in search of a farm look over the beautiful counties of Grant, Iowa, Lafayette, Green, and Dane, before he goes farther west, and he will hardly fail to find one to his mind. A vast accession to the farming population of the district may be expected as soon as these erroneous impressions are removed. Its prairies and openings will be laid out into farms, whose owners will enrich themselves from the products of the fertile soil. Its hills and vallies will be dotted with rural homes, adding new beauty to the charms of nature; and its solitudes will be made glad by the stir of happy and successful industry.

CHAPTER XI.

MINERALOGY.

Under this head, I will present a brief notice of the prominent minerals of the lead district, and the processes by which those of them which are valuable may be prepared for use. For want of such accurate knowledge, mineral resources often remain unknown, or if known, undeveloped and useless.

Sulphuret of Lead.—Galena.

This is the ore from which most of the lead of commerce is derived. It is of bluish gray color, with a shining metallic lustre, sometimes splendent. Cleavage generally perfect, cubic, occasionally found fibrous and granular. In many localities the crystals are very perfect and beautiful. They are generally cubes, called by the miners "cogs." These are sometimes elongated, so as to form right square prisms, or the edges and corners truncated, forming octahedrons, and dodecahedrons. The ore is generally reduced in blast furnaces, and the lead is run into moulds, forming bars of about 70 pounds weight, called "pigs." The average yield is about sixty-eight per cent.

For the chemical constituents of this mineral, see the report of Dr. Hayes, on galena, at the end of this chapter.

Sulphate of Lead.—Anglesite.

This ore occurs in small quantities. It is generally found in crystals, nearly transparent, having a vitreous lustre and slight tinge of green. The galena is often studded thickly with these crystals, especially where it occurs in small cavities.

Carbonate of Lead.

This is known as "white mineral" among miners. It is found massive, having no metallic lustre or appearance. It is generally of a white or light gray color, but is somtimes colored darker. It fractures very much like a piece of compact limestone. It consists, chemically, of the oxide of lead, 85.46, carbonic acid, 16.54. It occurs with the galena, generally in soft ground. It is sometimes found in a pulverulent form, coating the galena, and known as "mineral ashes." It has resulted from the decomposition of that ore. It is valuable as an ore of lead. About 20,000 pounds were raised at "Brigham's mine," near the Blue Mounds, and small quantities have been found in many localities. It is sometimes confounded with sulphate of baryta, from which it can be distinguished in the manner I have described in treating of that mineral.

Carbonate of Zinc.

This ore has very little of the metallic character in its appearance. It is massive, assuming sometimes a stalactitic or mamillary form, with a spongious texture, like encrusted moss. It is popularly known as "dry-bone." Its color varies from white with a pearly lustre, to light brown and green. It occurs abundantly in veins, associated with galena, at Mineral Point, Dodgeville, Mifflin, Franklin, Platteville, Shullsburg, Hazel Green, and other places. It is the most valuable ore of zinc known. For a fuller account of this ore, see report of Dr. Hayes, and chapter on "Zinc ores of Wisconsin."

Sulphuret of Zinc.—Blende.

This ore of zinc, known as "black-jack," is very common. It is generally massive; color, green, brown, or black; lustre, resinous. Frequently in crystals, disseminated through the vein-stone or the adjacent rock. Fine crystalized specimens are sometimes mistaken for tin ore. For chemical composition, see table of analysis. This

ore has been used for the manufacture of metallic zinc, but it is so much inferior to the carbonate, or dry-bone, as to be used with profit only where that ore cannot be obtained. It may be ground and used as a mineral paint.

Sulphuret of Copper.

This ore is usually of a brass yellow color. It resembles iron pyrites, but is distinguished from that mineral by being easily cut with a knife, and failing to strike fire with steel.

Carbonate of Copper.

Generally of a light green, gray, or blue color; earthy and massive fibres, with a silky lustre; sometimes crystalized regularly, with a vitreous lustre, and deep azure hue. In this last form, it is often mistaken for crystals of colored quartz, and furnishes specimens of rare beauty. The carbonate and sulphuret of copper are generally combined. They occur in veins, usually perpendicular, in the lower beds of the gray limestone. They have been worked at Mineral Point, where they have yielded about 15,000,000 pounds of ore. Most of this was smelted in the vicinity, and gave from 15 to 20 per cent. of pure copper. No work has been done on these veins for several years, and it may be questioned whether present indications are sufficiently favorable to warrant an extensive outlay. A small vein, also, has been struck in the same rock at McKnight's copper diggings, section 8, town of Wayne, and copper ore has been found near Centreville. Indications of copper have also been observed in several other localities. But until further examinations be made, it is impossible to pronounce upon their value. No discovery of this ore has been made in the same vein with lead, so far as I am aware.

Iron.—Brown Hematite.

A variety of this ore is found occasionally, forming the matrix of the lead; color, brownish yellow; structure fibrous, when broken presenting often a mamillary surface. It accompanies the

vein in parallel bands with clay. When ground, this ore forms yellow ochre. Red ochre, known as iron rust, is often found in immense quantities in the veins. It is often followed as an indication of a "lead." Its origin can be traced to the decomposition of iron pyrites.

Sulphuret of Iron.—Iron Pyrites.

This mineral is found abundantly throughout the mines. It is the brilliant substance, called sulphur or "mundic." It occurs in nearly every form known to the mineralogist, and furnishes specimens of unsurpassed beauty. Occasionally the galena is coated over with this substance. In some cases the rock near a vein seems to have been broken up, and pyrites introduced, cementing the mass together into a kind of breccia. The cavities are lined with octahedral crystals of a bronze color. This ore is often mistaken for gold, from which it is distinguished by not being malleable. The chemical composition of this ore is 55 parts of sulphur, 45 of iron. It is used for the manufacture of copperas, which is prepared from it by the simple process of leaching and evaporation. It is also used for the manufacture of alum, and sulphuric acid. The increasing demand for these articles confers a high importance upon this ore.

It decomposes very rapidly, when exposed to the air. Where piles of it have been thrown out around the mouth of a shaft, the soluble copperas, formed from its decomposition, is often washed down by the ruins, and collected in the pools around, where it is left upon the evaporation of the water. In Mr. Looney's level, section 11, town of Benton, a most beautiful illustration of decomposition and recomposition occurs. A heavy vein of pyrites is here imbedded in very pure clay. The level has been cut through this, giving free access to the air. The ore has decomposed, forming copperas, which effloresces in delicate crystals upon the sides of the level. A portion of the sulphur has been left pure. Another portion, uniting with the oxygen of the atmosphere, formed sulphuric acid, which, uniting with the clay, produced the sul-

phate of alumina, or alum. All these substances may be seen here in the process of formation. Nothing can be more instructive to the naturalist, or more interesting to the reflecting mind, than the contemplation of these silent mutations of matter, constantly going on in the great laboratory of nature, around and beneath us.

Sulphate of Lime.—Gypsum.

This substance has been found in only one locality. It occurs at Fairplay, about 60 feet below the surface, in veins traversing a bed of clay. It is white, with a fibrous texture and satin lustre. Owing to its great depth from the surface, the extent of the deposit cannot at present be ascertained. It is used as a mineral manure, under the name of "Plaster of Paris;" and also for taking casts, stereotyping, and as a cement. I believe this is the first discovery of gypsum yet made in the State, except in the drift.

Sulphate of Baryta.

This is the heavy spar of the miner. It is generally of a white or yellowish color, vitreous lustre, and so heavy as to be often mistaken for white lead ore. It has even been carried to the furnace and tried for lead; and upon failing to yield that metal, the report has been circulated that the "white mineral" has been tried and found worthless. It is however distinguished from that ore by a little care. It is softer than the carbonate of lead. It has a glassy lustre, while that is lustreless and earthy in appearance. The lead effervesces with acid; the baryta does not. This spar is ground and used as white paint, forming Venice White by combination with white lead. The article here is of good quality for such purpose, and is found in considerable quantities.

Water Lime.

Discoveries of this valuable substance have been made in several localities, which promise to be of value. But I am not prepared to report upon them until fuller examinations have been

made. It is of great importance that good hydraulic cements should be furnished from the rocks of our own State, as we are now making heavy importations of this bulky article from abroad. Early and thorough attention will be devoted to an examination of all rocks, which promise to be useful in this particular.

Building Stone.

The rocks of this portion of the State furnish excellent material for building purposes, but great care is required in making a selection. The different layers in the same quarry often vary much in their texture and composition, so that close discrimination is needed to obtain such as will weather alike. In this climate, where sudden freezes are so common after winter rains, if a rock is porous it can hardly escape destruction, however hard and compact it may appear, when taken from the quarry. The water insinuating itself into the minute pores, expands suddenly by freezing, and bursts it apart. When stone is to be selected for an edifice, of any considerable value, especially if designed for public purposes, every precaution should be taken to ascertain the real quality of the rock, before it is used. For want of such care many of our public edifices in older states are only monuments of folly; and at this early juncture, while our cities are yet to be built, we may take advantage of their experience.

REPORT OF DR. HAYES ON THE GALENA OF WISCONSIN.

The results of assays of seven specimens of galena, as marked and numbered by EDWARD DANIELS, Esq, Geologist to the State of Wisconsin, are as follows:

No. 2. East and west vein from Brigham's, near Blue Mounds. —A clean mass of galena.

One assay ton (2000 lbs.) of this galena, assayed for lead, afforded 1600 lbs. The lead obtained when assayed for silver, less 1 25-100 oz. silver.

No. 3. From a north and south vein, New Diggings.—Another variety of galena.

One assay ton, assayed for lead, afforded 1628 pounds. The result for silver hardly differed from No. 2.

No. 4. From an east and west vein New Diggings.—Another form of Galena.

One assay ton, assayed for lead, afforded 1580 pounds. The proportion of silver was the same as in 3.

No. 5. Fibrous galena, from Franklin, supposed to contain silver largely.—A sample differing from the last in form.

One assay ton, assayed for lead, afforded 1586 pounds. The proportion of silver was nearly the same as in No. 4.

No. 6. North and south vein, Potosi.—Sample differing in form from the last.

One assay ton afforded 1680 pounds lead. The result of the assay for silver was the same as in the other samples.

No. 7. East and west vein, Potosi.—Another variety of galena.

One assay ton afforded 1600 pounds of lead. This lead contained the same proportion of silver as the last.

No. 8. From a dry bone sheet, Messersmith's, near Dodgeville. —This sample was somewhat mixed with foreign matter.

One assay ton, afforded 1520 pounds of lead. The proportion of silver in the lead was the same as in the above.

The analytical trials here given were performed on samples of galena, presenting different physical characters, and two of them had the color, form, and hardness of argentiferous galenas. The proportion of silver estimated on the yield of lead, is remarkably near the same in the different samples. The silver in this minute quantity seems to belong to the galena, whatever may be its form, and its detection and separation are not easily effected.

The per centage of lead afforded, is that of an assay, and will serve as a guide in pointing out what returns should be obtained from smelting operations as carefully conducted.

It will be seen that the ores, after being broken from gangue, should produce 1600 pounds of lead, from 2000 pounds of ore, were the smelting processes perfect.

Respectfully,

AUG. A. HAYES,

Assayer to State of Massachusetts.

Boston, 20th January, 1854.

CHAPTER XII.

IRON ORE OF DODGE AND WASHINGTON COUNTIES.

This deposit of iron ore consists of a bed of great horizontal extent, included between layers of limestone above, and a bed of clay, underlain by limestone, below. It presents an occasional out-crop along a distance of fourteen miles, and may be traced, with frequent interruptions, through the whole distance from Iron Ridge, Dodge county, in a south-east direction, to the town of Hartford, in Washington county. It varies in thickness from 8 to 30 feet. It undoubtedly extends over at least ten or twelve square miles, constituting one of the most extensive beds of iron ore known. It presents every evidence of being an included stratum, having a distinct stratification conformable to the rocks above and below it. The whole formation of rocks dip slightly towards the east. The structure of the ore in place is usually that of small flattened nodules, cemented together. By partial decomposition, the ore on the surface has been separated into its constituent nodules, which resemble flax seed in their size, color, and greasy feel. This loose material is called seed ore. Occasional lumps of compact hematite occur, which seem to be a secondary form of the ore. The limestone adjoining the bed of ore is frequently discolored by it, and crystals of hematite occur, lining its cavities. True analyses have been made of this ore, the detail of which I have not by me at this moment. They prove it to contain about 50 per cent. of iron, combined with alumina, silica, manganese, &c.—This per centage is eminently favorable, as any addition of iron beyond 60 per cent. diminishes the working value of the ore, except for transportation. The combination is such in this case that the ore reduces readily, without the necessity of any flux except

the accompanying clay. The experiments recently made upon the quality of the metal produced prove it equal in toughness to the best American iron. Two companies have been organized to work this ore—the North-Western Iron Company, and the Hartford Iron Company. The North-Western Company have now in operation a steam blast furnace at Iron Ridge, capable of producing from six to eight tons of pig iron per day. They contemplate erecting two furnaces, of a superior capacity to this, at the same place. I am informed by CHARLES BURCHARD, Esq., of Waukesha, an active member of the company, that pig iron can be produced at these works cheaper than at any furnace in America. The ore delivered at the furnace costs only fifty cents per ton. The immense forests amid which it is located furnish abundant fuel, while its peculiar composition renders it very cheaply reduced.

Not a single furnace for the manufacture of pig iron exists west of Indiana, except at Iron Ridge. The demand for this material is very great, and is constantly increasing. This deposit of ore is practically inexhaustible, and when extensive works are erected upon it, a source of wealth, whose value can scarcely be overrated, will be developed.

Of the operations of the Hartford Company, I have no definite information at hand. Among its principals, however, are numbered BYRON KILBOURN and HIRAM BARBER, Esqs., whose connection with such an enterprise entitles it to the confidence of the public.

The works of the North-Western Company have been placed under the superintendence of JAMES TOWER, an Iron Master of great skill and large experience.

This brief notice is given here merely to call attention to the value of this deposit of ore. The examinations upon which it is based were made two years ago, with the exception of a hasty reconnoisance the present season.

A thorough survey of the iron district will be made at an early day, and presented in a future report.

COMMUNICATION OF H. A. TENNEY:

MADISON, December, 1853.

Prof. E. DANIELS, *State Geologist:*

SIR.—In compliance with your instructions I herewith forward a brief preliminary report upon the general physical features, soil, scenery, and some of the most characteristic features of the geological district surveyed during the past season, embracing the south-western counties of the state.

A description of so large a district, and in so brief a space as this communication, it is but proper to premise, must be taken for what it purports to be—a general one—not applicable always to particular localities, but to the country as a whole, and even then is to be received with some grains of allowance.

There is a great degree of uniformity in the general appearance and contour of the surface of the district. Its most striking features are its broad prairies and woodlands, steep and high ridges, contracted and deep ravines and gorges, and mounds towering far above the general surface. The summit level of the highlands is nearly uniform, averaging, apparently, about five hundred feet above the Mississippi river; and, from the many abrupt slopes, narrowness of the ridges, and rapid descent of ravines and water-courses, the drainage throughout is both speedy and complete.

The channels of the rivulets and rivers have uniformly sharp and angular outlines, strikingly different from the valleys of streams in the middle and eastern portions of the state, and characteristic of the hard and flinty deposites through which they have been excavated. Their walls or banks are always abrupt—often vertical, and of great height. There are no broad bottoms or alluvions, or large level tracts of upland—neither marshes, lakes, or any marks indicating their recent existence. The surface is every where too high and rolling to admit the existence of standing or stagnant water. The hills and ridges have a determinate shape and order of arrangement, in marked contrast with the irregularity and accidental form of the drift hills and ridges elsewhere—no traces of which deposite are found in any portion of the district under consideration. It must not, hence, be inferred that it is, in the common sense of the term, rough or broken. On the contrary, seven-eights of the surface might be advantageously cultivated. Springs are abundant, and wood and water generally diffused, so that there are but few obstacles to successful agriculture.

The surface soil of the prairies is generally a vegetable mold; but clay predominates in the timbered tracts. A sub-soil of clay every where prevails. In the absence of chemical analysis, the composition of either can only be inferred; but there can be little question that they possess all the elements essential to an enduring fertility, and are adapted to the cultivation of every variety of crops that flourish in a temperate climate. A heavy deposite of clay, of variable thickness from five to fifty feet, covers the stratified rocks, concealing them from view, except in the vertical grooves made by water courses, and upon the slopes of occasional declivities, which have a naked and barren appearance, contrasted with surrounding evidences of fertility. It seems probable, from examination, that the materials of this deposit were derived from the decomposition of the rocks whose place it occupies, and that it was of fresh water origin.

All the lower lands of the district are covered with a rank

growth of vegetation, and for numberless ages have been enrich ed by its annual decay. Every rain transports fertilizing elements from the higher to lower levels, perpetually adding to the productive qualities of the soil, which, in the common course of cultivation can never become greatly impoverished; and even in the absence of all manuring, must long yield a profitable return to industry judiciously applied.

The rock formations throughout the district retain their original and nearly horizontal position, undisturbed since their deposition by any apparent violent elevating or upheaving force; and, on examination, exhibit a continuity easily traceable in every portion of it. Yet that such forces have at one period operated with considerable intensity, is evident from the present configuration of the surface. The deposites have all, to a greater or less extent, been fractured, and in directions usually corresponding with the cardinal points; and the fissures thus created have manifestly determined the course of ravines and channels of water courses.

Every portion of the district exhibits evidence of long continued abrasion and denudation. The immensity of the change thus wrought, is most strikingly demonstrated upon examination of the present condition, form, and structure of the principal mounds. These ancient land-marks of the olden world are the most prominent and picturesque objects in the scenery of the state—monuments of ages of change and revolution anterior to the creation of existing organisms—and which, from some peculiarity of texture and composition, or from having been original centres of elevation, have withstood the ravages of time and tempests, while surrounding rocks have crumbled to dust, and their materials been removed to distant and lower levels.

The height of these mounds varies from six to twelve hundred feet above the level of the Mississippi river. On ascending them the several strata found, lie above, and differ essentially from, the common surface rock of the district; and, at about corresponding levels, are identical in color and texture, order of superposition, chemical composition, and fossil contents. Although now so

widely detached and apparently isolated, this arrangement of strata furnishes undoubted evidence of their former continuity over all the intervening country; and, as there has been no local elevation, the conclusion is inevitable that from three to five hundred feet in vertical depth of the former surface deposits have been broken up and carried away. Had it not been for such immense changes, or had the drift formation so widely diffused elsewhere over the state, covered the district, the metalliferous treasures of the lower formations must have ever remained hidden or to a great extent unavailable.

Extended and magnificent views of the scenery of the southwest may be had from the summits of all these elevations, as each one overlooks a large district of country. The western peak of the Blue Mounds, however, from its greater height, affords the most extended and complete prospect in the state, if not in the north-west. Standing on this point, over a thousand feet above the adjacent Wisconsin river, and five hundred above the general summit level of the surrounding country, a charming and diversified view of western scenery is spread out to the spectator, embracing, with a clear sky, an area exceeding one hundred miles in diameter. The boundaries of this view southward, are the high hills and bold peaks of Illinois; and farther west and low down upon the horizon, the ridges back of Galena, and Sherald's Mound in Iowa, about seventy miles distant. The view westward is bounded by the bold bluffs of the Mississippi, backed by the wooded heights of Iowa, extending northward full sixty miles.—North is seen the dividing ridge between the Kickapoo, Pine, and Baraboo rivers, Bear, Honey, and other creeks, and the valleys of the LaCrosse and Lemenwoir. And eastward the eye loses itself amidst forests and prairies stretching away to the limits of vision, and blending with the light haze and deep blue of the atmosphere.

The filling in of this immense picture is as gorgeous as the frame work is vast and magnificent. Radiating from the highlands, and traceable by lines of forest, are seen the valleys of Sugar River, the Pecatonica, Galena, Platte, Grant, Blue, and Wisconsin riv-

ers, as also those of the Wyoming, Otter, Blue Mounds, and Black Earth creeks. The three Platte Mounds, although near forty miles distant, appear as near neighbors in the landscape—while Sinsinawa, some thirty miles further, marks the south-western limits of the state. Bold and rugged highlands, and deep, dark gorges define the valleys of streams flowing from the southward into the Wisconsin; and numberless dells and jagged peaks mark the embouchures of streams coming in from the north. The bluffs of the Baraboo, six hundred and ninety feet in height, stand out in relief against a back ground of forest and prairie, presenting a peculiarly rugged and picturesque landscape. Innumerable groves dot the surface of the prairies which in the summer season appear like seas of waving grass—sometimes in long and wavy lines—now dark and dense—now light and fleecy, through the distant openings of which appear the dim outlines of villages, or the light smoke of the lead furnace. But all mere description is tame in comparison with the real beauty and grandeur of such scenery.

The ascent to all the mounds is quite easy. An almost insensible rise of many miles terminates at the base, and though their sides are broken and abrupt, there is little practical difficulty in gaining their summits. They are usually covered with groves or thickets, which have gained a foot-hold since the commencement of settlements, and the suppression of the annual fires. The same remark is equally applicable to most of the timbered lands of the district. They have grown up within the memory of the earliest settlers; and, with proper caution, no reason exists why within a few years, it may not become a well timbered country.

Mining is at present the absorbing interest of the district; but agriculture is steadily gaining in importance. The uncertainties of mining throw a charm about it not possessed by other industrial pursuits. Perseverance and hope are essential to the successful prospector. Years of patient toil have to be balanced against the chance of sudden wealth. The work though severe, is not thought unhealthy, as custom limits the hours of labor below that of other pursuits. Taken as a whole, the occupation pays as well, and it

may be better than other industrial avocations. It necessarily leads to habits of close observation, and the fact is now well understood that the discovery of large mineral deposites is not often a matter of chance—that the lodes have not an accidental arrangement, but have resulted from a law general in its operation, and which may in time be ascertained and comprehended.

There is no portion of the west more attractive than the mining country. In climate, health, and capacities for material profit, it is no where excelled. Its home markets have always been good, and it will soon enjoy the facilities of a ready and cheap transit for surplus productions. It is believed there is no exaggeration in the prediction that it is destined to become the wealthiest portion of the state.

Respectfully submitted,

H. A. TENNEY.

APPENDIX.

CIRCULAR OF THE STATE GEOLOGIST.

The following circular was issued soon after my appointment.—It has been responded to by many public spirited citizens, and I most eaanestly entreat attention to the matter of which it treats:

CIRCULAR OF THE STATE GEOLOGIST.

Fellow citizens:—Having been commissioned to execute the Geological survey recently authorized by the Legislature, I venture to invite your co-operation. The objects of this survey are to ascertain the character, position, thickness and horizontal extent of the various beds of rock, which occur in our State. To discover the location, quality, mode of occurrence, and amount of all valuable mineral snbstances; to analyze the soil in various localities with a view to test its agricultural capacities, and determine its proper uses, and the best means of improving it. And, in general terms, to collect and arrange, all knowledge that can be obtained of the physical resources of Wisconsin.

By this means, our own citizens, and the world at large will be furnished with reliable information concerning our natural endowments as a State. The dissemination of such knowledge will invite population, hasten the development of our known resources of wealth, and at the same time open up new mineral treasures, as yet undiscovered. In this way, every citizen is to be a sharer in the substantial benefits of the survey, and has a direct interest in its successful prosecution.

The sum of money appropriated to this work, though probably as large as the financial condition of a State so young as ours would

warrant, is small when compared with the labor to be performed. This deficiency, however, must be balanced so far as possible, by judicious management, and such voluntary assistance as the intelligence and patriotism of the citizens at large may prompt them to render. With the limited means at our disposal, it rests with you, to a great extent, to decide how much shall be accomplished. To give a profitable direction to any co-operative efforts which may be made, I offer a few practical suggestions, of the highest importance to the interests which we propose to advance, by a Geological survey.

1st. Observe the character of the rocks, if any are exposed in your vicinity, whether they are arranged in layers, (stratified) or occur in irregular masses; (unstratified) whether they contain any curious petrifactions, or shapes of animals or plants in stone.

2d. If there are different beds of rock lying one above the other, as sandstone, limestone, &c., note their thickness, extent upon the surface, and order of superposition.

3d. In excavations for railroads, canals, sinking shafts for wells, mining, &c., preserve specimens of the rocks, clays, soils, &c., of every foot in depth, and take careful minutes in writing, of the order in which they occur.

4th. Collect specimens of all rocks, clays, marls, peats, and all soils remarkable either for productiveness or sterility in your vicinity. These should be fair average specimens, and such as would afford by analysis, a test of the composition of the entire mass from which they are taken.

5th. Carefully preserve all petrifactions, and all bones, teeth, tusks, or other remains of animals found in the soils, clays, gravels or elsewhere.

6th. If beds of limestone, fit for marble; grindstone quarries; sand, which might be used for glass, &c.; clay for pottery; metallic ores; or any mineral substance, which in your opinion, might be valuable, occurs, collect and forward specimens of each kind.

7th. Where veins of ore are being worked, (in the "lead region particularly,) notice their length, direction, increase and dim-

inution in thickness, as they traverse the rock, depth below the surface, and product of ore. Accurate drawings of particular veins which can be prepared easily by the practical miner, as he works them out, would be of great value.

8th. Note such facts as have, or may come under your observation, which seem to prove that lead has been formed at recent periods, and is still slowly accumulating.

9th. Will the owners of all works for the reduction of ores, furnish a statement of the amount of ore worked, costs and method of reduction, and pure metal produced within the year.

10th. In general, collect all specimens, and facts, which in your opinion will be interesting or useful to be generally known.

Specimens of rock or ores should be about 4 inches square.—Petrifactions should be sent whole, whatever may be their size; if broken in extracting from the rocks, carefully preserve the fragments. Soils may be put up in four ounce vials. Each specimen should be wrapped in paper by itself with a label, stating its precise locality, written with ink. When thus prepared, specimens may be forwarded in a box carefully packed, to the *State Geologist, Madison, in care of the Governor.* They may be sent by the member elect from each assembly district, who will no doubt see to their safe delivery as a matter of public interest, or forwarded by any other means which may be thought proper.

All communications may be directed to E. DANIELS, *State Geologist, Madison*, where they will be sure to reach me at any time.

By following these suggestions, every citizen can render an essential service to the State, and promote the common interest of its people; and at the same time, be acquainting himself with important facts, and contributing to the advancement of sound science.

To the young men of the State, especially, would I appeal.—You have the will and energy, and power to do; you are to live, and take your part in the growing destinies of this young commonwealth. Give your aid then to the developement of her resour-

ces, and the advancement of her material prosperity. Seek out what provisions a bountiful Providence has made for you in her fertile soil, on her beautiful surface, and in the treasured depths of her generous bosom. Your patriotism can bring to her no more grateful offering; your energies can be enlisted in no nobler service. The field operations will occupy several months of the year, and will afford excellent opportunities for the instruction of such young men as may wish to learn the practical applications of science in this direction.

EDWARD DANIELS,
State Geologist.

MADISON, April, 20th 1853.

GLOSSARY

OF GEOLOGICAL AND SCIENTIFIC TERMS EMPLOYED IN THIS REPORT.

A

Anticlinal Axis.—Where the strata dip in opposite directions, like the sides of a roof, the line towards which they rise is called an anticlinal axis.

Arenaceous.—Sandy.

B

Boulders.—Rocks which are often found in fragments lying upon the surface or loose in the soil, frequently rounded by attrition, and generally differing from the underlying beds. They have been transported from distant localities.

Black Jack.—Sulphuret of zinc.

Breccia.—A rock composed of angular fragments cemented together.

C

Conformable.—When strata are arranged parallel to each other, like the leaves of a book, they are said to be conformable.

Crop Out.—The emergence of a rock at the surface, lying in place—as where the strata have been worn through by a stream, their edges will crop out upon either side of the valley.

Crystalline.—An assemblage of imperfectly defined crystals, like loaf sugar and white marble.

Calcareous.—Composed principally of lime.

Coral.—A hard calcareous secretion formed by certain marine animals.

Champion Lode.—The principal lode of a group of veins.

Comb.—The parallel arrangement of the ores and vein-stones in a lode.

Cap, or Cap Rock.—The layer of rock which covers an opening or expansion of the lead-bearing fissures.

Cotemporaneous.—Of the same age.

D

Drift.—Deposits of boulders, gravel and sand, which are found spread over the surface of the rocks, supposed to have been dispersed from the northward by the action of waves and icebergs.

Dip.—Where strata are not horizontal, the direction in which they sink is called the direction or their dip.

E

Eruptive.—A group of rocks having a common origin.

Fossils.—The remains of animals and plants found buried in the earth or enclosed in rocks. When the organic matter has been replaced by mineral substances, they are called petrifactions.

Fossiliferous.—Containing fossils.

Float Mineral.—A term used in the mines to describe the loose ore which has been left by the wearing away of the rocks.

Fault.—A dislocation of the strata, so that the layers of rock upon one side of a fissure have slidden past those corresponding to them on the other.

G

Galena.—An ore composed of lead and sulphur.

Geology.—A science which has for its object to investigate the structure of the earth, the materials of which it is composed, the order in which these are arranged, and the action of those great natural causes which have produced and are still producing changes upon its surface. Economical Geology applies those facts to the useful purposes of life.

Granite.—An unstratified rock composed principally of quartz, feldspar and mica.

Ground.—In mining, the rock through which the veins are worked is called ground. Dead or barren ground is such as yields no ore upon working.

H

Hornstone.—A siliceous mineral, resembling flint in its characters.

Hade.—The deviation of a descending vein from a perpendicular line, is called its hade or underline.

Horse.—See Vein.

I

Igneous.—Formed by the action of fire.

L

Laminæ.—The thin layers into which strata are often divided.

Loam.—A mixture of sand and clay.

Lode.—Any productive metalliferous vein.

M

Matrix.—Those substances included within the walls of a metal-bearing fissure, and accompanying the ore, are called the matrix of the ore; sometimes, also, the gangue or vein-stones.

Mammillary.—Studded with small segments of spheres, like the swell of the breasts.

Mineral.—This term includes in its proper signification all substances which do not belong to the animal or vegetable kingdom—even air and water are minerals.

Mineralogy.—The science which treats of the nature and classification of minerals.

Mastodon.—A class of extinct animals, allied to the elephant.

N

Nodule.—A rounded irregular shaped lump or mass.

Nucleus.—The central point around which the matter of a nodule is arranged.

O

Outliers.—Hills or ridges of rock strata occurring some distance from the general mass of the formations to which they belong. They have been caused by the wearing away of the strata which once connected them with the main mass of the formation.

Oxide.—A combination of oxygen with another substance.

Oolite.—A rock composed of small rounded particles, resembling petrified fish spawn.

Opening.—The expansion of a crevice forming a cave; or a large extent of soft ground, often containing large quantities of ore.

R

Rock.—All beds of mineral matter, whether of sand, clay, or firmly aggregated masses, are called rocks.

S

Shale.—Hardened clay, usually divided into thin laminæ.

Stalactite.—A concreted deposit hanging from the roof of caves like an icicle.

Stalagmite.—Crusts formed by the dripping of water upon the floor of caves, which holds in solution some mineral substance. The stalactite and stalagmite are formed by the same process.

Strata.—Layers of rock parallel to each other.

Shaft.—A vertical excavation sunk upon a mineral vein for the purpose of reaching its ores or ventilating the mine.

Segregation.—The drawing together of scattered particles to form one mass.

Strike.—(Synonymous with the "line of bearing.") The direction in which the edges of the strata crop out.

Stratification.—An arrangement of rocks in parallel layers.

T

Trap Rock.—A variety of the igneous rocks often found in connection with mineral veins, and which has been thrown up from below in a melted state like lava. It is not found in the mines of the Lead District.

Throw.—Interruption in the usual course of a vein.

V

Vein.—The mineral contents of a vertical or inclined fissure.

Vitreous.—Resembling glass.